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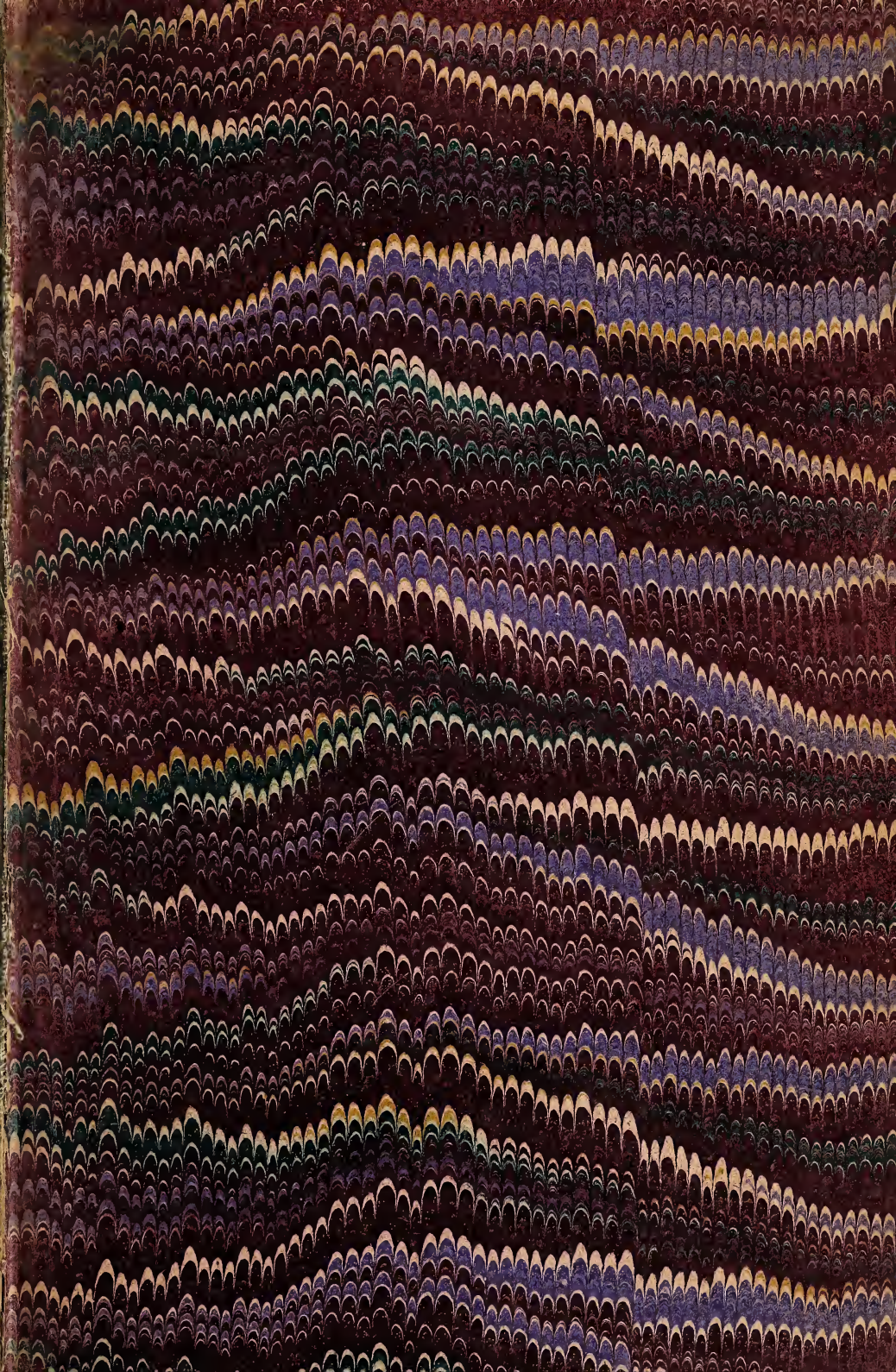
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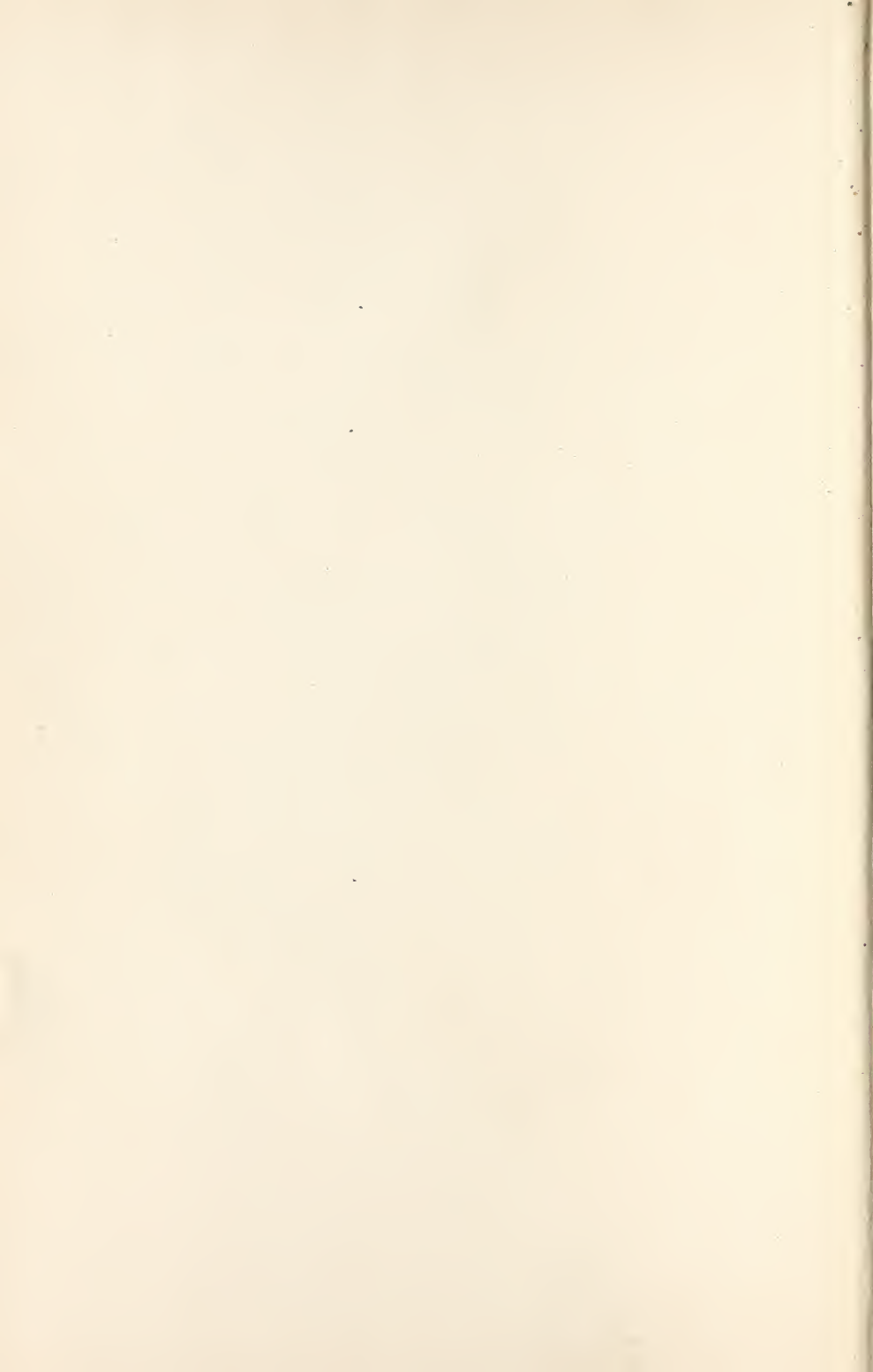
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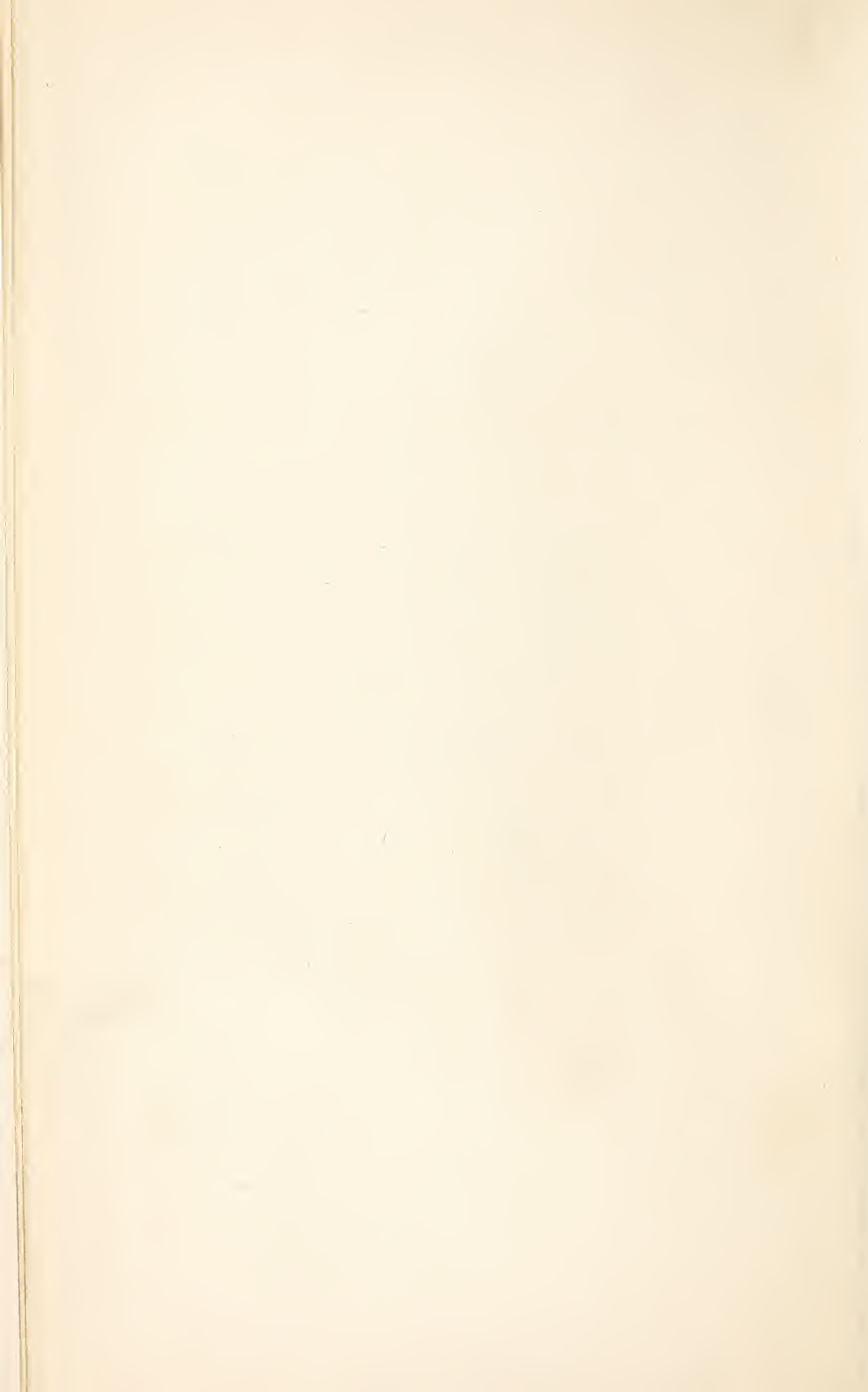
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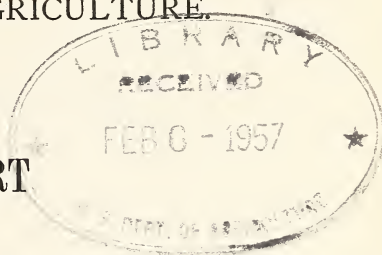


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U. S. DEPARTMENT OF AGRICULTURE.



ANNUAL REPORT

OF THE

OFFICE OF EXPERIMENT STATIONS

FOR THE YEAR ENDED JUNE 30,

1910.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

JOINT RESOLUTION Providing for printing annually the Report of the Director of the Office of Experiment Stations, Department of Agriculture.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed eight thousand copies of the Report of the Director of the Office of Experiment Stations, prepared under the supervision of the Secretary of Agriculture, on the work and expenditures of that office and of the agricultural experiment stations established in the several States and Territories under the act of Congress of March second, eighteen hundred and eighty-seven, for nineteen hundred and three, of which one thousand copies shall be for the use of the Senate, two thousand copies for the use of the House of Representatives, and five thousand copies for the use of the Department of Agriculture; and that annually hereafter a similar report shall be prepared and printed, the edition to be the same as for the report herein provided.

Approved, April 27, 1904.

THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Ph. D., Sc. D., Director.
 E. W. ALLEN, Ph. D., Assistant Director.
 Mrs. C. E. JOHNSTON, Chief Clerk.
 SARAH L. SOMMERS, Record Clerk.
 E. LUCY OGDEN, Librarian.

RELATIONS WITH STATE AGRICULTURAL EXPERIMENT STATIONS.

The DIRECTOR and ASSISTANT DIRECTOR.

W. H. BEAL.
 W. H. EVANS.
 J. I. SCHULTE.

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 J. I. SCHULTE, B. Agr., } Field crops.
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 J. B. MORMAN, M. A., Rural economics.
 E. J. GLASSON, B. S. A., Horticulture and forestry.
 W. A. HOOKER, B. S., Economic zoology, entomology, and veterinary medicine.
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 WILLIAM HENRY, Indexing and proof reading.

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Scientific assistants.—F. G. HARDEN, A. M., R. D. ROBERTSON, B. S., and S. H. BECKETT, B. S.

Agent.—J. W. LONGSTRETH, in charge of work in Kansas.

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Irrigation farmers.—J. H. GORDON, R. G. HEMPHILL, B. S.; W. H. LAUCK, R. E. MAHONEY, and JOHN KRALL, Jr.

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A. D. MOREHOUSE, M. E., Office engineer and acting chief in absence of the chief.

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Engineers available for special work.—A. E. MORGAN; S. M. WOODWARD, M. S., M. A.; C. F. BROWN, M. S.; L. L. HIDINGER, B. C. E.; J. T. STEWART, B. S. in C. E.

LETTER OF TRANSMITTAL.

OFFICE OF EXPERIMENT STATIONS,

Washington, D. C., March 8, 1911.

SIR: I have the honor to transmit herewith the annual report of the Office of Experiment Stations, the publication of which is authorized by joint resolution of the Fifty-eighth Congress, second session. This includes a report on the work and expenditures of the agricultural experiment stations established under the act of Congress of March 2, 1887, and further endowed under the act of Congress of March 16, 1906, for the fiscal year ended June 30, 1910, in compliance with the following provision of the act making appropriations for this department for the said fiscal year:

The Secretary of Agriculture shall prescribe the form of the annual financial statement required under the above acts, ascertain whether the expenditures are in accordance with their provisions, and make report thereon to Congress.

Very respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.



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ANNUAL REPORT OF THE OFFICE OF EXPERIMENT STATIONS, 1910.

WORK OF THE OFFICE OF EXPERIMENT STATIONS.

The general character of the work of the Office of Experiment Stations was not changed during 1910, and included the supervision of the expenditures of Federal funds by the agricultural experiment stations in the several States; conferences and correspondence with station officers regarding the management, equipment, and work of the stations; the collection and dissemination of information regarding the progress of agricultural education and research throughout the world by means of technical and popular bulletins; the management of the agricultural experiment stations in Alaska, Hawaii, Porto Rico, and Guam; the promotion of the interests of agricultural colleges and schools and farmers' institutes throughout the United States; special investigations on irrigation and drainage, conducted largely in cooperation with experiment stations, educational institutions, and other agencies in different States and Territories; and the investigation of problems relating to the food and nutrition of man.

RELATIONS WITH THE AGRICULTURAL EXPERIMENT STATIONS.

The relations of the office to the work and expenditures of the experiment stations continue to increase in volume and variety. While these center primarily on the Federal funds, as a matter of fact they extend to practically all phases of the station activity, including organization, administration, and general policy.

The popularity of experimental work and confidence in the stations have led to increasing appropriations to them for a wide range of duties in the field of investigation, demonstration, and inspection. The multiplicity of their present duties and the pressure upon them for all forms of extension enterprises have raised a large number of administrative questions, and required the outlining of a more fixed policy as applied to the use of the Federal funds. The department's administration of these funds has been modified with a view to meeting the requirements of the changed conditions due to the broader development of the stations and the colleges with

which the stations are connected. This has led to a more exact limitation of expenditures from these funds to those directly connected with experimental work and the publication of the results thereof. In February, 1909, announcement was made through a circular letter that, beginning with the fiscal year 1909-10, no expenses could be permitted from Federal sources for extension work or the issuing of extension bulletins. This has led to a closer scrutiny of the accounts for such expenditures during the past year, and in places where there has not been a clear understanding to occasional readjustment. In a number of instances disallowances have been necessary as a result of inappropriate charges, and in less serious cases promise has been required of a change of practice before the financial reports have been approved.

One important result of the year's inspection, therefore, has been a clearer understanding as to the elimination from the Federal funds of all expenses for extension enterprises, and a putting into practice of the policy of confining the use of the Federal funds strictly within the limits of conducting experiments and investigations and reporting the results of the same.

The treatment of the station work in the text of popular bulletins, in such manner as to distinguish such bulletins from mere compilations of information from general sources and to give the station credit for its work, has received considerable attention. This has been strongly urged as desirable from the standpoint both of the reader and of the station, for it shows the source of the experimental evidence on which directions or generalizations are based and definitely connects the preparation and issuing of such bulletins with the station's work. The public, which does not usually distinguish between these different branches of activity, should be led in that direction as far as possible.

To meet the demand for studies of problems involving special or local conditions, the work of the stations is being scattered over the States more broadly than formerly. There has been increased activity in the establishment of demonstration and experimental farms under State appropriations, and in a number of States such work is now organized on an extensive basis. Aside from this, the station experts are extending their investigations to particular localities where special problems or conditions are presented. Where the Adams fund has been expended in connection with such outlying investigations, it has been desirable to include these in our annual inspection, and this has increased the time required for an examination of the station work.

During the year several cases have arisen which have called for an unusual amount of attention from the office. These have usually been associated with the removal of the director of the station. There

has been rather more than the usual amount of unrest and unsettled conditions growing out of the relations of boards of control with directors. Where the efficiency of the station work under the Federal funds has been involved, it has been necessary for the department to interfere and to prescribe conditions which must be recognized and met by the local authorities. In some instances this has resulted in the temporary withholding of the Federal funds, and in the enforcement of the principles which must govern in the selection of station officers and in the management of the institution. As long as boards of control continue to have a wrong impression of their duties to the station and a wrong attitude toward its conduct, the office will be called upon to deal with these matters, and to restrain the local authorities from action clearly detrimental to the station. The practice of boards in interfering in the conduct of work after the general plans have been approved, and with the expenditure of funds for the purposes necessary to carry out such work, is a misconception of their duties which it has been necessary to combat firmly in a number of instances.

It has also been necessary to urge with greater emphasis that the nature and extent of the station work now require that the directors, as well as members of the staffs, shall be men well trained in agricultural science, and that their tenure of office shall be as permanent as that of the heads of departments in our best colleges and universities.

Questions relating to the administration of the experiment stations demand increasing attention. At the present stage this is one of the most important matters relating to the stations. In many instances the magnitude of the enterprise, when there is coupled with it the direction of the college of agriculture, the extension work, and the State inspections, has clearly outgrown the old form of organization. Provision is needed by which more attention and consideration will be given to the conduct of the station on the business side, and in the direction of its experimental and other work. A large majority of the difficulties which the office encounters in its administration of the funds are attributable to the lack of such provision. In some of our largest agricultural institutions it is now very desirable that the immediate management of the stations shall be committed to officers specially charged with that function. For this purpose an increase of the administrative force should be made and the duties of administrative officers further differentiated. The tendency to leave important administrative matters to clerks, accountants, or other persons not acquainted with the character and purpose of the station work is much to be deprecated.

One result of the broadening activities of the stations is a too general use of the Hatch fund for administrative and similar expenses

without sufficient definite experimental work. The office has maintained that the Hatch fund should not be largely drawn upon to provide for the general administration of the stations operating with liberal State appropriations, but that it should be used mainly for definite experimental work in much the same way that the Adams fund is. It is more and more evident that those stations which have no regular State appropriation will find increasing difficulty in meeting the calls upon them in the way of simple or local trials, the giving out of general information, answering miscellaneous correspondence, preparation of popular bulletins, etc.

The States have been increasingly liberal in the matter of appropriations for maintenance and for buildings and equipment. The revenues of the stations for the year aggregated nearly \$3,000,000, and fully half of this came from State and local sources. But these revenues are frequently not available for meeting general expenses for maintenance, being provided for special purposes; and this fact has unduly increased the burden for maintenance against the Hatch fund.

While the office is following closely and criticizing frankly the work and expenditures of the stations, it is also deeply impressed with their increasing scientific and practical strength and the importance of their operations, as well as the growing appreciation of the results of their work by the agricultural people throughout the country and abroad. The granting of Federal aid to original research through the Adams Act has materially raised the level of scientific aim and accuracy, and established new standards for thoroughness and fundamental work. Instead of minimizing their more practical work, this has led the States to increase largely their funds for substations and special experimental work. The American system of agricultural experiment stations is, therefore, more comprehensive, far-reaching, and permanently established than ever before.

INSULAR EXPERIMENT STATIONS.

It is a pleasure to note the growing appreciation of these stations and their work, as is shown by the more frequent requests for aid in the solution of individual problems, local contributions toward the expense of experiments, and greater demand for the publications. This appreciation is not confined to the immediate constituency of the stations, but the published results of their work are being sought by other countries having similar problems, and recently formal permission was granted a foreign government to reprint certain of their bulletins. The work of the Hawaii and Porto Rico stations on tropical fruits, the Hawaii investigations on rice, cotton, and manganese soils, and the Porto Rico studies on the cause of the so-called "sick soils" and means for their improvement have all attracted wide

attention. These are connected with fundamental problems of tropical agriculture and the results can be applied under like conditions anywhere.

No change has been made in the policy of any of the stations, diversified agriculture being the aim of each, and some results are beginning to be apparent. The first commercial crop of cotton in Hawaii in half a century was produced during 1910 as a result of the showing made by the experiments of the station. The growing of leguminous cover crops is being adopted in Hawaii and Porto Rico. The value of windbreaks as a protection to orchards against the trade winds is also becoming appreciated, and they are being planted by the more progressive horticulturists. The suggestions of the Alaska stations regarding the preparation of the soil, methods of planting, varieties, etc., are being quite generally adopted. In Guam, where work was begun only a little more than a year ago, the value of some of the new crops has been recognized and many requests have been received from the natives for material for planting. The adoption of a small cultivator introduced by the station shows the open-mindedness and willingness of the ranchers to adopt new crops and methods when their superiority is demonstrated.

The increase in buildings and equipment kept pace with the incomes of the stations, and the facilities for carrying on investigations are fairly adequate for the problems now in hand and the means for work will compare favorably with institutions in other countries similarly situated.

The various bureaus and offices of the department continue their generous assistance to the work of the several stations by supplying material and information, and it is desired to acknowledge here their cordial cooperation.

The administrative business of this office in its relations with the insular stations continues to be under the charge of Dr. Walter H. Evans, chief of the division of insular stations. The character, scope, and results of some of the lines of work of the stations are summarized below.

ALASKA STATIONS.

The early part of the season of 1910 was not favorable to field and garden crops in Alaska, but from midsummer on the climatic conditions became more satisfactory and the favorable conditions continued until late in the fall. This made it possible to grow many plants to a better degree of maturity than often happens, and the success reported with some crops was all that could be desired. The work at the several stations has been continued along the lines described in previous reports. The principal investigations at the several stations are horticulture at Sitka, grain growing and cereal breeding at Rampart, general farming and adaptation of crops at Fairbanks,

and stock breeding at Kodiak. Other lines of work are being conducted at each station, and data are being rapidly accumulated that will soon make possible the answering of questions relating to possible crop production in all of the more important regions of the Territory. The reports received from the different stations are most satisfactory and reflect credit upon those who are carrying on this important work.

At Sitka, where the principal work in horticulture is carried on, the season was favorable to vegetable growing, and excellent results were obtained with all the common hardy kinds. In the plant breeding work the success with strawberries mentioned in previous reports has been maintained. During the past year nearly 2,000 hybrid plants were under observation, and it is believed that at least a score of them will prove thoroughly adapted to the coast region of Alaska. Most of the hybrid strawberries proved to be shy bearers, but occasional plants were found to be exceedingly prolific, one producing 200 berries. A large proportion of the plants produce berries comparable in size with the average strawberries of the markets, and in addition they partake of the flavor and firmness of the wild berry. A few plants of the hybrid made between the salmonberry and the cultivated raspberry have fruited, but the fruits did not show any improvement over the parental types. The attempt to secure the hybridization of the native Alaskan crab apple with pollen from early and hardy varieties of apples from the Northern States has been continued, but some years will have to elapse before results can be obtained. As in former years, considerable work is being done in testing bush fruits of various kinds, and these are being propagated and distributed over the Territory for trial as rapidly as possible. Currants, raspberries, and gooseberries have been found to succeed nearly everywhere, but the apple and cherry trees that have been distributed have made but little, if any, growth. It seems almost certain that none of the present varieties of these fruits can mature in Alaska, and the only way to success lies in the development of varieties from hardy wild species. Some work is being carried on with ornamental plants, and the Tartarian honeysuckle and Japanese rose (*Rosa rugosa*) have been established and are doing remarkably well. In addition to the experiments with fruits, the testing of many varieties of potatoes with a view to selecting those best adapted for general culture is being continued at the Sitka station.

At the Rampart station, where cereal introduction and breeding are the chief lines of investigation, the success reported in previous years was repeated. At this station, which is located in the Yukon Valley at 65° 30' N. latitude, practically all the winter wheat, winter rye, and spring-sown barley and oats matured. Spring-sown wheat

failed to mature. Frosts that injured potato tops and other tender vegetables did not appear to appreciably hurt the cereals. It is gratifying to be able to report the practicability of growing hardy, early maturing varieties of barley, oats, winter wheat, and winter rye in the interior valleys of that Territory. Systematic work is being conducted on cereal breeding at the Rampart station, and by cross-fertilization new varieties of barley and oats have been produced that from their first season's growth appear very promising. This work will be continued to provide varieties of the important cereals that are especially adapted to local conditions. Some additional land was prepared for cultivation at Rampart, so that about 25 acres are now available for experimental purposes.

At the Fairbanks station results similar to those described for the Rampart station were secured. This is very gratifying, as the work there was only recently begun and immediate success was not expected. The work is chiefly that of maintaining a general farm. Sixty-five acres are under plow and some 40 or 50 acres cleared for meadow. The principal work during the past year was the growing of oats for feed and grain, the object of the experiments being to determine whether hay and grain can be profitably grown in the interior of Alaska. In order to more efficiently care for the crop a self-binder reaper was added to the equipment of the Fairbanks station during the year. It is believed that this was the first machine of the kind taken to Alaska. An experiment on growing potatoes on a commercial scale was undertaken, 11 acres being planted to that crop. Frost caused considerable injury to the plants on the lower flat lands, but the potatoes planted on the slopes suffered but little injury. After providing seed for future planting there remained of the crop over 300 bushels to be sold. Ten acres additional land were cleared and plowed during the summer, and progress was made toward the erection of some much-needed buildings. The superintendent of the Fairbanks station devoted some time during the summer to a reconnoissance of the Tanana River Valley with a view to determining roughly the agricultural capabilities of that region preliminary to a detailed regional survey by the Department of the Interior.

The stock-breeding work is all done at the Kodiak station. The Galloway cattle brought there three years ago are doing well and are proving adapted to the climate and the country. The station suffered no material losses in cattle during the past year, and although the snowfall was the heaviest on record, the stock kept in excellent condition throughout the winter on native hay and silage put up on the ranch. The object of this experiment is to test the adaptability of these cattle to Alaskan conditions, to develop their milking qualities if possible, in order to make them an all-purpose breed,

and to produce surplus stock to be sold to settlers at prices not much in excess of those for which common cattle can be brought into the country. At the end of the fiscal year there were 61 pure-bred Galloways of all ages at the station. The work for the past year was highly successful, and a late communication from the superintendent in charge of that station states that the cattle had been fed but once up to December 4, 1910. The autumn having been an open one, the stock maintained themselves on the ranges. Their condition was reported as excellent. The efforts to develop a milking strain of Galloways are being continued, and it is desired to add to the herd by purchasing additional cows that are known to be fairly good milkers.

The sheep-breeding work is a new feature, having been introduced during the past year by the purchase of 40 ewes. Most of these sheep have been bred in Alaska and are thoroughly acclimated. The sheep are mostly Cotswold and Merino grades, and it is intended to introduce rams of a large breed, such as the Lincoln. At the end of the fiscal year the flock of sheep had been increased to 74 by the birth of lambs.

The cooperative work with farmers and gardeners was continued, the station distributing seeds and plants for trial throughout the Territory. Reports are received of the successes and failures, and in this way it is possible to quickly determine the value of new introductions.

HAWAII STATION.

A new office building was erected during the year from funds supplied by the Territory of Hawaii, and the old concrete building with some modification was turned into laboratories. An additional area of about 10 acres, situated at an elevation of about 250 feet, has been brought under cultivation and is planted to cotton, bananas, and papayas, and some planting has been done about the office and other buildings. The principal buildings of the station are situated on land formerly reserved by the Navy Department and occupied by the Department of Agriculture by agreement. On March 25 an Executive order was issued transferring this tract to this department for use as an experiment station. Cooperative experiments with corn, cotton, pineapples, rubber, rice, sorghum, and a number of miscellaneous forage crops are being carried on at very slight expense to the station on a number of large plantations with very satisfactory results.

The investigations of the agronomist on rice, cotton, and forage plants progressed very favorably. Assisted by the chemist, a rational system of applying fertilizers to the rice crop has been worked out. Extensive fertilizer experiments with rice have been carried on, and

it has been demonstrated that the proper time to apply fertilizers for rice is before planting and not with the irrigation water during the growth of the plant, as has been the practice. The rice plant was found to take up its plant food early in its growth, and the stooling or tillering was greatly increased by the early application of the fertilizers. It has also been found that ammonium sulphate is a better source of nitrogen for rice in Hawaii than sodium nitrate; in fact, there appears to be some evidence that the rice plant, especially when submerged, does not use the nitrates directly. During the year the agronomist visited Japan and China for the purpose of studying the rice industry in those countries. The Japanese, who make up more than 40 per cent of the population of the islands, prefer Japanese varieties of rice even though they cost more than the domestic ones. To produce this type of rice, seed of about 150 varieties were obtained for experimental purposes, and of four a sufficient quantity of seed was secured to test their qualities when grown on a considerable scale in Hawaii.

The experiments with cotton, begun three years ago, have yielded such striking results that 500 acres of commercial plantings have been made with every prospect of increased areas being devoted to this crop in the coming year. It has been definitely determined that cotton can be grown at any elevation up to 1,600 feet above sea level and with a precipitation varying from 25 to 100 inches, although a moderate rainfall gives the most favorable results. The experiments are principally with sea-island and Caravonica cottons, and as these plants are perennials in Hawaii it is necessary to control their growth to prevent their becoming too large. Experiments have shown that the form of the plant and the time of crop production can largely be controlled by pruning, and that the prunings can be utilized for propagating. Although this method may not prove a commercial success, it has proved valuable in the propagation of pure strains of cotton where the possibility of crossing could not be eliminated. The tendency to heavy production of cotton was shown in a field of sea island, where the plants averaged 700 bolls at six months, and some individuals bore as many as 1,200 bolls. This heavy load, especially on the lateral branches, tended to bend the plants to the ground, injuring the lint, and as a consequence experiments are in progress to secure plants with shorter limbs and of a more upright habit of growth. The Caravonica plants are stronger and more upright in habit of growth, and while the yield of lint during the first year was very small, the second year a heavy crop was obtained. The strong growth, greater ease of picking, and high percentage of lint make this a desirable crop, and there is little choice between this and sea-island cotton. Some strains of Egyptian cotton experimented with grew vigorously and yielded better than sea island, and it is probable

that Egyptian cotton can be added to the types grown in Hawaii. In experiments on the use of fertilizers for cotton, the value of phosphates in increasing production has been clearly shown, increases of two or three fold over check plats being obtained.

Attention is being given to corn breeding, broom corn, etc. Through the influence of the station there is considerable interest in the growing of leguminous plants for cover crops and for forage. Pigeon peas, cowpeas, and jack beans are being extensively grown, the pigeon pea and jack bean doing exceedingly well. Cowpeas are subject to attacks of plant lice, but where these pests have been absent the crop has been one of the best. The success attained with leguminous plants has led to the adoption of rotation of crops, especially where pineapples are grown. An experiment with sugar cane has also shown that rotation for this crop is profitable, at least under some conditions. A fertilizer experiment on a plantation that has been in taro for fully 200 years was begun, and an opportunity will thus be given to determine the fertilizer requirements of this crop.

The station chemist continued his pineapple investigations, the studies including the effect of manganese on the plant, the process of ripening of the fruit, and the utilization of the by-products from the canneries. The injurious influence of manganese on pineapples has been mentioned in previous reports. Studies were undertaken to ascertain what crops, if any, could be grown in rotation with pineapples or to replace them on manganiferous soils, but with little promise of success. Where less quantities of manganese are found in the soil, the addition of fertilizers composed of superphosphates, sulphate of ammonia, and sulphate of potash will overcome the injurious effect to a considerable extent. These investigations have led to the discovery that the most serious drawback to pineapple culture in Hawaii is a lack of proper aeration of the soil. The soils contain large amounts of iron, and as a result they are easily puddled after a rain or irrigation and air can not penetrate to the roots. Preliminary experiments have shown the value of drainage in increasing the aeration of the soil. A study of the ripening processes of the pineapple has shown that the sugar content of the fruit is directly influenced by the degree of ripeness when cut, there being no increase after the cutting of the fruit, although a green fruit may turn yellow and become soft. The large waste of materials about the pineapple has led to investigations which have shown methods whereby they can be profitably utilized.

The horticultural investigations were continued along previous lines, the attempt being made to induce a more general growing of improved varieties of tropical fruits. Satisfactory progress was made in propagating mangoes and avocados, and the method for mango propagation described in the previous report of the station

continued to give good results. Some attention is being given to the varieties of avocados in the Territory, and four have been found to have especial merit and they will be propagated as rapidly as possible. Experiments are also in progress in improving the papaya. It has been found that by the use of the pistillate plants in an orchard the nonbearing staminate plants can be eliminated. Enough perfect flowers are produced for the purpose of fertilization and the seedlings from such fruits are either all pistillate or perfect, and the results of crossing are eliminated. Marked differences in quality, shipping, etc., have been noted and the experiments are being conducted to improve these characters. Shipping experiments with sweet potatoes were undertaken during the year, and it was found practicable and profitable to ship them to San Francisco during the early summer before the California crop has begun to come in.

The entomologist continued his studies of insect pests of agricultural crops with a view to their control. Especial attention has been given the insects attacking sweet potatoes in Hawaii, and a bulletin prepared on the subject. Attempts are being made to introduce parasites of the algaroba bean weevil, but the results thus far can not be safely forecasted. Extensive additions were made to the collections of economic insects, and much work in breeding and life-history study is in progress.

The cooperative work on the rubber plantations was continued. The commercial plantings have all been made at elevations of 1,400 feet or below, and satisfactory growth is reported. The Ceara rubber trees continue to grow more rapidly than the Hevea trees, and the extensive planting of Hevea trees will depend on whether the yield of rubber will ultimately be enough larger than that of Ceara to warrant the longer waiting for the first tapping. The advantage of clean cultivation of rubber plantations is shown by the much more vigorous growth of cultivated trees. Where cultivation can not be practiced owing to the rocky nature of the soil it was found desirable to destroy the weeds by other means. Spraying experiments were tried for the destruction of weeds among the rubber trees, and it was found that the ground could be cleared of all weeds by spraying with arsenite of soda. About 400 acres were successfully cleaned in this way at a cost of about \$1.25 per acre.

The work of the station continues to be of great practical importance, and the relations with the people of the islands are most cordial and helpful. In order to bring the results of investigations within the observation of many who can not otherwise be reached, the station has taken up the problem of establishing demonstration farms in different parts of the islands. The funds are supplied by the Territorial government, and it is proposed, as far as possible, to work through the most successful farmer in the different homestead

communities. The work will be planned and directed by the station, and the results can be interpreted by the man locally in charge. The work for the present will be largely on better methods of cultivation, rotation, and the introduction of new crops.

PORTO RICO STATION.

The office and laboratory building provided from insular funds was occupied and the installation of the equipment completed during the past year. The building has proved a model of comfort and convenience. The station and its work are being more appreciated each succeeding year, if the increased number of visitors, the growth of correspondence, and requests for advice and assistance are any criterion of the estimate placed upon it. While, of necessity, much work is done that is of an elementary and demonstrational character, efforts are continually being made to draw the work into more definite lines relating strictly to tropical conditions, with a view to determining some of the fundamental principles underlying a rational system of tropical agriculture.

One of the lines to which especial attention is being paid is soil investigations. The climatic conditions in the Tropics have a peculiar effect on the soils. It was shown in the previous report that certain anaerobic bacteria tend to accumulate in the soil, and the products of their activity are detrimental to plant growth. It has been found that disinfecting the soil with chemicals, burning, or fallowing tends to correct these injurious conditions, and the station is working on cheap and efficient methods of partial soil sterilization. The physiologist of the station, who discovered that the areas designated as "sick soils" contained abnormal amounts of butyric acid resulting from an accumulation of anaerobic bacteria in the soil, has continued his investigations, studying especially the rôle of protozoa in soils and methods for the economical disinfection of soils. The experiments on disinfection were conducted with soils that had become so infested with butyric-acid organisms as to render the cultivation of lilies impossible. A number of disinfectants were tried and the best results were obtained with carbon bisulphid and chlorid of lime. The results indicate that chlorid of lime is one of the best and cheapest soil disinfectants known.

The chemical department during the past year carried out a large amount of analytical work on new varieties of sugar cane, waters, limestones, guanos, and other fertilizing materials. The research work was chiefly devoted to studies on soils and plant nutrition. Among the subjects of soil studies were the formation of calcareous hardpan, injury by alkaline waters, lime requirements of soils, etc. A large amount of work has been done on the causes and means for correction of the chlorosis of pineapples in certain districts of the

island, which appears to be due to unfavorable soil conditions. It appears that a content of more than 2 per cent of calcium carbonate in Porto Rican soils renders them unsuited for the growing of pineapples. Treating the chlorotic plants with iron sulphate resulted in restoring the normal green color to the leaves and in stimulating the growth, but it is doubtful whether such treatments can be made commercially profitable. In connection with this investigation a study has been begun on the lime-requiring plants and those which do not thrive in the presence of lime. In view of the results of these investigations it is recommended that other crops, as tobacco, coconuts, pigeon peas, etc., be planted where the proportion of lime is found injurious to pineapples. Some studies on the lime and magnesium ratio for plants have been begun, and a series of water cultures is in progress.

The entomologist continued his studies on the insect pests of citrus trees and has prepared a bulletin describing the principal insects and suggesting means for their control. In the preparation of this bulletin it was necessary to test the methods of combating insects in other regions, and in many instances some modifications in the formulas for preparation of the insecticides or their application was necessary to adapt them to Porto Rican conditions. By fumigation, spraying, and the introduction of windbreaks about the trees, so as to permit the rapid growth of beneficial fungi, it has been found practicable to keep the insects in check on most orchards. An investigation has been begun on the injury to coffee trees by ants. The ants live preferably on the shade trees, but colonies were found on coffee trees, where they do some damage. Experiments with repellents have shown that some may be found defective. An extensive study has been made of *Lachnosterna* sp., an insect resembling the May beetle. Its larvæ are particularly troublesome in cane fields. The beetles feed principally on certain weeds, and spraying the weeds with arsenate of lead was found to destroy the most of the beetles. Carbon bisulphid injected into the soil destroyed the grubs, and experiments are in progress with lime and other fertilizers to prevent, if possible, the depositing of the eggs in the cane. A parasitic mite has been found on the larvæ of the beetle, and its work is being watched with great interest. Studies have also been made of the insects attacking guavas, and the life history of a number of species is being worked out. Through the activities of the station a deep interest has been aroused in beekeeping, and a number of nuclei of broods have been disposed of to go to coffee plantations. At one time the station was instructing 15 persons in the handling of bees, methods of raising, and the production of honey. The entomologist made a visit to Cuba during the year to compare some of the insect problems of that island with those in Porto Rico.

The plant pathologist studied the diseases of a number of economic plants; among them were those occurring on coffee, cacao, pineapples, citrus fruits, sugar cane, and bananas. It has been found possible to control the coffee-leaf blight by spraying just before the beginning of the wet season. Experiments are in progress looking to the control of the coffee disease due to *Stilbum flavidum*. The effect of trenching about trees to prevent the spread of a root disease is being tried. The experiments on soil disinfection for the prevention of the Fusarium on pineapples have been so successful that the treatment on a field scale was made during the past year. Experiments have shown that spraying with Bordeaux mixture can not be depended upon to control citrus scab in Porto Rico, as is claimed to be the case elsewhere. A study has been begun on the fungi causing root injuries to sugar cane, in which the fungi have been isolated and as far as possible identified. A disease of bananas, apparently due to a species of Fusarium that enters the plants through the roots, is under observation. It has given little trouble until the present year, and studies of methods for its control have been begun. A bud rot of coconuts has been found in a few localities, and as a somewhat similar disease is very destructive elsewhere in the West Indies it will be given attention.

The work with coffee, in addition to the experiments in the renovation of old plantations and establishment of new ones, includes investigations with foreign coffees, methods of transplanting, viability of coffee seed and means for preserving it, methods of fertilizing and cultivation adapted to different types of soil, etc. Among the foreign coffees introduced by the station a number of trees have borne and the station has limited quantities of seed of Padang, Maragogype, Preanger, a Ceylon hybrid, and the famous Blue Mountain coffee of Jamaica that may be had for planting purposes. These are among the highest-priced coffees of the world, and 3-year-old trees have yielded over a pound of cleaned coffee to the tree. The work with coffee will be considerably extended. Severe windstorms caused many of the coffee berries to fall from the trees, and as a result the crop was considerably less than it otherwise would have been. Experiments have been begun on the value of windbreaks in connection with coffee planting, and some of the species planted are ready for testing. The result of the renovation experiment of the old plantation for 1910 showed a production of 260 pounds per acre, the cost of which for the year was \$5.25 per hundred pounds. Practically all the seed produced on the new plantation was distributed for planting or used in testing, and no financial statement for the year is possible.

The horticulturist devoted much attention to a study of some of the problems of citrus fruits, as that industry is developing quite

rapidly in Porto Rico. An experiment to determine the losses in transit of carelessly handled fruit showed that 22 per cent of bruised fruit, 11 per cent of fruit pulled from the stems, 38 per cent of fruit cut by clippers, and only 5 per cent of sound, carefully handled fruit had decayed after 14 days in storage. This shows that the great losses of citrus fruits are due to careless handling. The variety plantings of citrus fruits began bearing during the past season, and within a few years the relative value of the more important varieties for planting in Porto Rico should be definitely known. The value of growing cover crops in orchards has been given attention for some time, and it is becoming a common practice to grow them during the period of heaviest rainfall. Tests are now being made of a large number of leguminous cover crops to determine which are best suited to the prevailing conditions.

Considerable additions were made to the collection of mangoes, and the station now has growing 62 distinct varieties besides numerous seedlings. Experiments are in progress with various methods of propagating the mango, and the most satisfactory method, at least for old trees, is by bark grafting. Plantings of additional species of rubber-yielding trees have been made and a tapping trial of some 8-year-old *Castilloa* trees was conducted, the herringbone system being used, but this method does not appear suitable to this species in Porto Rico. Plantings of vanilla, cacao, and other economic plants have been made, and the station's collections of these plants are being rapidly extended. A study has been begun on the reasons for the rapid deterioration of vegetables grown from northern seed, lettuce, tomatoes, beans, okra, radishes, beets, and cantaloups being experimented with.

The work in animal husbandry has been largely confined to the introduction and acclimatization of improved breeds of live stock, and some results of the introductions are beginning to be shown. Some trouble has been met with in the introductions of stock by reason of diseases, but methods for overcoming them have been learned. Horses have suffered from osteoporosis, but in several cases the disease has yielded to treatment. Glanders affect horses and mules of the island, but the station stock has thus far been free from it. Ticks infest cattle at certain seasons and tend to keep them somewhat emaciated, but otherwise do little damage. The progeny of American saddle-bred horses bred to native mares have matured into handsome animals that command very high prices. The station has introduced six more horses during the year to continue the work. The cross-bred zebu bulls introduced by the station in 1909 have developed splendidly, and they will be used to improve the size of the native cattle. The woolless sheep introduced from Barbados a year ago have proved well adapted to their surroundings, but need some improvement in

their meat-yielding qualities. The breeds of pigs and poultry introduced by the station are proving adaptable to Porto Rican conditions and the surplus is in great demand by planters and breeders. Continued experiments with cane tops and corn as silage have shown the importance of the silo as an adjunct to stock keeping. A study is being made of various stock feeds, concentrates being but little used in Porto Rico. There does not appear to be much prospect for the local production of concentrated feeds and more attention should be given to those forage crops which can to some extent supplement the present scarcity. This must be done by the planters before there can be a very extensive improvement in the stock situation. During the year more sanitary and commodious buildings for the farm live stock were erected.

GUAM STATION.

The purchase of the tract of land leased by the station from Juan Torres was completed and the transfer of the property made according to the laws and customs of Guam. The purchase price, \$1,300, is considered very reasonable, and the station now has a permanent location. The land was cleared of its tropical growth and fenced, some roads were constructed, and necessary buildings were erected or are in course of erection. Of the 32 acres that are adapted to general agriculture all but 5 or 6 are now under cultivation. In order to supply the station with water for irrigation and other purposes a well was dug that gives an abundance of good water, and an engine, pump, and pipes were secured to convey the water to points where it is needed.

The work of improving the station has proceeded exceedingly well, when it is understood that nearly all supplies must be sent by transport from San Francisco, and all the planning and much of the oversight of the work devolve directly on the special agent in charge. A capable foreman has been secured and the burden somewhat lightened.

The greater portion of the available land has been planted to forage crops of various kinds. One of the lines of work which it is desired to take up is the introduction of better live stock, but before that can be done a regular supply of forage must be assured. On this account especial efforts were given to the production of forage, and Kafir corn, Egyptian corn, broom corn, sorghum, milo maize, Johnson grass, Guinea grass, *Paspalum dilatatum*, peanuts, mung beans, jack beans, cowpeas, soy beans, and velvet beans were introduced and are under comparison. Kafir corn produced large yields of green feed when planted during the dry season, and when cut the plants sent out new shoots and quickly produced a second crop. The ratooning habit was found to apply to a number of crops in

Guam that are ordinarily grown as annuals elsewhere. Among the grasses, *Paspalum dilatatum*, a native of Brazil that has become established quite extensively elsewhere, gives promise of the greatest value. Guinea grass, that was introduced from Hawaii, is also promising and it is believed that under more favorable circumstances it will yield heavily. Johnson grass, which was introduced into Guam some years ago under the name Samoa grass, was planted at the station, but it has thus far shown no superiority over the two other species mentioned. On account of its tendency to spread and to hold the ground, even against cultivation, it will not be distributed for general planting until its habits in Guam are better known.

The experiments with leguminous plants proved quite successful, so far as growing the plants was concerned. Cowpeas and velvet beans were found to grow readily and yield a large amount of forage, but where it was desired to enrich the soil by plowing them under the native plows would not answer the purpose. A variety of bush Lima beans was secured that produced an immense amount of leaves on fairly good soil and it was more easily plowed under. The soil of the station, although formerly in cultivation, has, through the common methods of cultivation, been depleted of much of its fertility. It is, however, typical of much of the farm land of Guam, and offers a good opportunity of demonstrating methods of enriching the soil through the use of leguminous crops, etc.

Some attention was given to corn culture and methods for improving it. Considerable corn is grown in Guam and it forms a staple article of diet, being largely used in the form of corn cakes. The special agent in charge introduced a small hand mill for grinding corn to take the place of the usual laborious method, and he is experimenting with the ground seed of Kafir corn as a substitute for maize meal. An experiment is in progress to determine a practicable method of storing corn and other grains. Great losses are occasioned by weevils and rots due to the excessive humidity, and as a result only limited quantities are commonly stored. A method of kiln drying and sealing in tanks was successfully tried as a means of preventing loss and providing a supply for future use.

A number of the fruits and vegetables introduced by the station are giving excellent results. Pineapples and avocados introduced through the Hawaii Experiment Station are thriving, the first avocados produced on the island being from seed sent to Guam from Honolulu for planting in the governor's garden some four or five years ago. Several varieties of sweet potatoes were introduced from Hawaii and they proved superior to anything previously grown in Guam. Experiments are in progress with a large number of other field crops and vegetables, and with some considerable success has been attained.

The station is striving to gain the confidence and interest of the people in its work, and for the short time it has been in operation the results seem quite satisfactory. The people seem anxious to obtain seeds of plants the value of which they can see, and some are quite interested in the implements and methods of cultivation that have been adopted. One of the most successful implements introduced was a small cultivator that cost about \$5. With one of these and a carabao a man can do more and better work in the field than 10 men can do with the native implements. The advantages of this cultivator were quickly perceived, and arrangements were made to supply a limited number of requests for them at cost. The introduction of these will doubtless be followed by a demand for other agricultural implements and tools and a decided advance in agriculture will be brought about.

The introduction of some improved live stock and the study of some of the more important insect pests and plant diseases are problems that are to be taken up as soon as possible. For the present the important problem is to interest the people in agriculture and get them back upon the farms. It is believed this can best be accomplished by simple experiments in which the elementary principles of agriculture are taught through ocular demonstration.

NUTRITION INVESTIGATIONS.

Foodstuffs of all sorts, both animal and vegetable, are agricultural products. Through its nutrition investigations the Department of Agriculture studies many questions which pertain to the utilization of foods, with a view to benefiting the producer, the distributor, and the consumer. As a whole the nutrition enterprise involves co-operation with other bureaus of the department when this seems desirable, and the supplementing, but not the duplication, of their work.

During the past year attention was given especially to experiments with the respiration calorimeter, and particularly to matters which have to do with meat and with cheese, to the application of the results of technical experiments to the preparation of food, to the preparation of bulletins, both technical and popular, and to meeting in other ways the public demand for data on nutrition topics.

The study of many of the practical everyday problems having to do with the nutrition of man as well as the investigation of complex problems necessitate the accurate measurement of the income and outgo of matter and energy and related factors. From time to time various methods have been proposed for accomplishing this end, and apparatus of a variety of types which would measure one or more of the desired factors has been devised. It has been generally con-

ceded that the respiration calorimeter, devised and perfected in connection with the nutrition investigations of the Office of Experiment Stations, adequately meets the requirements of the case and that the perfecting of the respiration calorimeter represents a great advance in experimental methods of importance in studying agricultural and other problems.

The respiration calorimeter, which has been installed in improved form at the Department of Agriculture, has been carefully tested and found fully satisfactory. During the year some accessory apparatus was installed which is of decided value since it very materially lessens the effect of external temperature upon the calorimeter, a matter of importance in connection with its use in warm climates and in localities subject to varying temperatures.

The problems studied with this apparatus during the last year have to do particularly with the relative ease of digestion of cheese and of meat as parts of a simple mixed diet. The results as yet obtained do not show that significant differences exist when the quantities eaten are comparable with those observed in the usual diet. This work was undertaken to round out investigations carried on in cooperation with the Bureau of Animal Industry on the relative nutritive value of cheese made and cured in different ways and of cheese of different sorts. From these experiments it has already been learned that cheese is digested very thoroughly by the average individual and that it is not a common cause of physiological disturbance as is often claimed. As a whole the work has demonstrated the high nutritive value of cheese and the possibility of its use in quantity in the diet as a source of both protein and fat.

Many tests have also been made of preparing cheese and meat for the table, to supplement the more technical work referred to above, and that which has been undertaken earlier with respect to the relative nutritive value and digestibility of different kinds and cuts of meat cooked in various ways. The results of the technical and practical studies with meat were embodied in a Farmers' Bulletin on the economical use of meat in the home, and the preparation of a similar bulletin dealing with the use of cheese as an economical and nutritious part of the diet was undertaken.

It is also proposed to study the relative value as sources of energy in the body of beef fat, vegetable oils of different kinds, butter, lard, and other edible or culinary fats, since experimental data on this subject are much needed in considering questions which are at the present time of special interest to the Department of Agriculture. It is also expected that some special studies of the nutritive value of honey will be undertaken, for which a demand has arisen.

The economical use of cereals, fruits, nuts, and vegetables, and products made from them can be studied by methods now available,

which would include work with the respiration calorimeter, and it is believed that such studies and the supplementary work along these lines which has already been done by the department could not fail to yield results of importance in discussing the available food supply with reference to economical and rational living.

It seems fair to say that the recent adaptation of the respiration calorimeter to experiments with vegetable products marks a decided advance in agricultural investigation. In work undertaken in cooperation with the Bureau of Chemistry studies have been made of ripening fruit (bananas), in which the gaseous exchange and energy output were measured during the ripening period. The results are of decided interest theoretically, and also for their bearing on problems relating to fruit handling and storage. Plans have been formulated for other investigations which have to do with questions of vegetable physiology in which the department is interested, the work to be undertaken in cooperation with other bureaus.

There are many problems concerned with the relation between food consumption and the production of useful work on the farm and in the home which are of great importance and special interest at this time, when so much attention is being directed to the problem of efficiency in the production of useful labor. Work already undertaken shows that such problems can be studied with the respiration calorimeter as readily and as satisfactorily as the relation of fuel to the production of work in an engine can be determined by the laboratory methods commonly used in the study of such a question. Indeed, it would seem that the respiration calorimeter or some similar device is a necessity if certain data are to be procured which are fundamental to the adequate discussion of problems pertaining to the production of useful work.

The question of insuring satisfactory luncheons for school children, and the related problem of supplying under municipal and philanthropic auspices food for needy school children, are assuming great importance and a widespread interest is manifested in this whole subject. Data regarding many phases of this question are frequently requested from the Department of Agriculture and can be supplied from the accumulated results of past experiments. However, some additional information should be sought by the improved methods of experimenting which are now available.

Requests are also frequently received from institution managers for advice and suggestions regarding food problems which arise when a large number of persons are fed under more or less uniform conditions. It is possible in this case also to supply a large amount of information derived from facts accumulated in connection with earlier experiments of the department. Here, too, additional data are much needed and could be readily accumulated.

The department investigations in nutrition and in kindred lines have a vital relation to the work of the agricultural colleges and experiment stations.

In response to a widespread demand from farmers and others, the agricultural colleges are offering courses in home economics in which instruction regarding the nutritive value of different foods and ways of handling and cooking them constitutes an important feature. The colleges have always looked to the department for aid in this line, and are now doing so more than ever. The agricultural colleges have been stimulated by a recent act of Congress to organize courses for teachers along this line as well as other branches of agriculture and mechanic arts. Secondary and primary schools all over the United States are taking up the work and the demand for teachers and for information exceeds the supply. Students, teachers, investigators, and interested individuals recognize the importance of the nutrition investigations of the department in this connection and turn to the department in increasing numbers for information and suggestions. This is only one phase of a great movement for improving living conditions in country and town by means of education directly related to home economics and the vocations of the people. It has long been understood that work of this character has been undertaken by the Department of Agriculture and the demand for information continues to increase.

Owing in large measure to the interest which the Department of Agriculture has taken in such questions, many of the experiment stations have devoted part of their resources to the study of nutrition problems and the interest in such lines of work is growing.

One of the most interesting features of the Department of Agriculture work is that the department is so generally regarded as a bureau of information by the public as a whole, and this is as marked with reference to nutrition matters as with other branches of agricultural work. The number of farmers' wives and other housekeepers and teachers and individuals who submit their problems to the department and ask for data and suggestions regarding food, nutrition, and other home problems is very large and constantly increasing. This means that directly and personally, as well as by means of its publications, experimental work, and its close relation with agricultural colleges and other educational institutions, the department comes in touch with the people of the United States and is able to demonstrate that its nutrition work is of interest and practical value as well as of scientific importance.

The results of the nutrition investigations, in accordance with the usual policy of the department, have been published in technical bulletins in limited editions, while the general deductions of popular interest which have been drawn from experimental work, have been

summarized in Farmers' Bulletins and other popular publications designed for general circulation, a total of 60 technical bulletins and 46 Farmers' Bulletins and popular summaries having been published up to the present time, together with numerous reports of progress and similar articles. That the data thus reported are of general interest is indicated by the fact that the demand for technical bulletins almost always exceeds the supply, while the requests for popular bulletins can only be met by reprinting them at frequent intervals. Of 22 Farmers' Bulletins on nutrition topics now available, the department records show that a total of over 7,000,000 copies have been distributed and almost entirely upon request.

During the past year 1 technical bulletin, a series of 15 colored food and nutrition charts, 3 Farmers' Bulletins, and 1 circular were issued. The technical bulletin reports the results of studies of calcium, magnesium, and phosphorus in food and nutrition. The food charts, which are of a size suitable for classroom use, are designed to show in graphic form the composition and nutritive value of a considerable number of food materials in common use in the American home. Outline figures representing a variety of food materials are divided in such a way that the proportions of water, protein, fat, carbohydrates, and ash are indicated and colored, so that the kind of nutritive material present and the relative amount may be seen at a glance in much the same way that the proportion of land and water in a country and the general character of the surface may be seen from a map.

The Farmers' Bulletins have to do with the economical use of meat in the home, with bread and bread making, and with the care of milk and its use in the home, the last-mentioned bulletin having been prepared in cooperation with the Bureau of Animal Industry.

The circular describes briefly the organization and extent of the nutrition investigations, the methods of distributing nutrition bulletins, and lists and describes the publications issued in connection with the enterprise. It is designed particularly to meet the requests for information received from investigators and other interested persons in various countries.

In addition to the above, a technical bulletin, a Farmer's Bulletin dealing with the economical use of cheese in the diet, and a circular discussing food in American homes have been prepared for publication, while several special articles and technical reports are approaching completion.

As a part of the regular work in nutrition, abstracts of the current literature on the general subjects of physiological chemistry and nutrition were prepared for the Experiment Station Record, as well as popular summaries, particularly of work carried on at the American experiment stations, for publication in the series of Farmers' Bulletins entitled "Experiment Station Work."

As has been the case for many years, many requests for information along nutrition lines were received from Members of Congress, teachers, institution managers, home makers, and others.

The work connected with nutrition investigations, as heretofore, has been in charge of Dr. C. F. Langworthy.

IRRIGATION INVESTIGATIONS.

For a number of years after this division of the office was established the headquarters of the field force were for the most part at two central stations. One of these was located at Cheyenne, Wyo., and represented the Rocky Mountain States; the other was at Berkeley, Cal., and represented the Pacific Coast States. This arrangement necessitated too much travel and was in other respects undesirable. Accordingly, during the past three years a reorganization of the field force has been undertaken by Dr. Fortier, the chief of this division. This readjustment consisted in placing an agent in charge of irrigation investigations in each State of the arid region. Already 10 State agencies have been established, and as soon as sufficient funds can be secured agents will be appointed in the other Western States. The wisdom of this plan has been fully shown by the results obtained since the change was made. It has been found that the agent whose duties are confined to a single State has a much better opportunity to become familiar with local conditions as regards irrigation and its allied subjects. This knowledge is necessary to one whose business it is to advise and instruct farmers and the officers of irrigation enterprises of all kinds with a view to bringing about better methods. If he is the right kind of man, the longer he represents a State the more knowledge he will acquire regarding its conditions and possibilities, and the more valuable will his services become.

In the following paragraphs are given a brief description of the work undertaken during the past year and of some of the more prominent irrigation features in each of the fields of operation.

CALIFORNIA.

The work in this State is under the general supervision of Frank Adams, with headquarters at Berkeley. He is assisted by V. M. Cone, in charge of the San Joaquin Valley, and by C. E. Tait, in charge of southern California. The State cooperates with this office in the work by contributing one-half of the funds necessary to carry on the investigations. A tract consisting of about 15 acres on the university farm at Davis has been set aside for experiments in irrigation. This tract is subdivided in such a way as to illustrate the various methods of applying water and in the channels which supply water different devices for the measurement and division of water

have been installed. Experiments have likewise been conducted to determine the duty of water on alfalfa, wheat, and corn.

Some interesting results have been obtained from experiments on the canals of the San Joaquin Valley to determine the effect of velocity upon seepage losses.

In southern California the investigations have included the methods and cost of cleaning canals, a study of the organization of mutual water companies, cost of pumping water, and the storage of flood water in the gravel beds of the Imperial Valley.

In addition to this work a study is being made of the conditions in Russian River and Napa River Valleys, in northern California, and in Santa Barbara and Ventura Counties, in southern California, to show the advantage of irrigation in regions where irrigation is not essential to crop production.

The Berkeley office is headquarters for instruments under the charge of E. J. Hoff, where instruments from all parts of the Union are sent for repairs. Here also new devices for measuring water are tested and both new and old current meters rated.

The published reports¹ of the agents in California during the past year comprise a bulletin on the Delivery of Water to Irrigators, by Mr. Adams; a circular containing a review of irrigation investigations in California, by the same author; a bulletin on Irrigation in the San Joaquin Valley, Cal., by Mr. Cone; a bulletin on the Use of Underground Water for Irrigation at Pomona, Cal., by Mr. Tait; and a bulletin on Irrigation in California, by Mr. Roeding.

WASHINGTON.

Mr. S. O. Jayne has been in charge of the work in this State for the past seven years, with headquarters at Spokane. He has been engaged for the most part in advising settlers regarding irrigation, although some experiments have been conducted at the Sunnyside station to determine the duty of water, evaporation losses, etc. A careful study has been made of the methods in vogue in districts where all the available flow of streams is now diverted for irrigation purposes with a view to bringing about a more economical use of the water and thus extending the irrigated area. The excessive use of water in some of the most fertile valleys has caused thousands of acres to become waterlogged, making drainage necessary. In other sections the soil is extremely porous and requires large quantities of water, and the problem there is how to prevent deep percolation beyond the roots of the plants. Through the efforts of this office much improvement has already been made in irrigation practice. Large areas of land in Washington are well adapted to fruit rais-

¹ U. S. Dept. Agr., Office Expt. Stas. Buls. 229, 236, 237, 239; Circ. 108.

ing, and expensive systems have been installed for supplying water to this land which makes an economical use of water of prime importance.

In eastern Washington a section of country is being settled and farmed by dry-farming methods, and these new settlers are becoming convinced that they must have a supplemental water supply to irrigate small areas as an insurance in seasons of extreme drought. Our agent has investigated the cost of installing and operating small pumping plants in this section. Mr. Jayne has assisted Mr. Byron Hunter, of the Bureau of Plant Industry, in the preparation of a circular entitled "Suggestions to Settlers on the Sandy Soils of the Columbia River Valley."¹

IDAHO.

Don H. Bark, located at Boise, is in charge of the investigations in this State. The work is carried on under a cooperative arrangement between the State experiment station, the State land board, several large irrigation enterprises, and this office. About two years ago a farm of 40 acres was established at Gooding, with John Krall, jr., in direct charge. Excellent results have been obtained at this station in determining the effect of different quantities of water on alfalfa, grain, potatoes, and other field crops.

Large areas of new land are being brought under irrigation in Idaho, and a great many farmers from humid sections wholly ignorant of irrigation methods have settled on these new farms. Our agents have done much through the local press, farmers' institutes, by exhibits at county and State fairs, and by personal visits to teach proper methods of preparing land and applying water.

An extensive investigation of the duty of water has been begun, embracing a variety of soil conditions and including all the standard crops. The investigations are carried on under field conditions, and it is believed the results will show the actual amount of water necessary for maximum yields under varying conditions and economical use. The results so far obtained have been published in the biennial report of the State engineer of Idaho.²

NEVADA.

Prof. Gordon H. True, of the University of Nevada, is in charge of this field and is assisted by F. L. Peterson. The work is under a cooperative arrangement between the State experiment station and this office and consists chiefly of experiments to determine the evaporation from irrigated soils and investigations of duty of water on grain and alfalfa.

¹ U. S. Dept. Agr., Bur. Plant Indus. Cir. 60.

² Eighth Bien. Rpt. State Engin. Idaho, 8 (1909-10), p. 220.

UTAH.

Prof. W. W. McLaughlin has charge of the work in this State, with headquarters at Logan. The State cooperates with this office through the experiment station, one-half of the expenses of the work being paid from State funds. This being the oldest irrigated section of the country, the work is naturally of a more technical and scientific nature than in the newer sections. A study has been made of the lateral and downward movement of the water in soil with different amounts of water applied at different times and with different methods of cultivation. In this connection studies have been made to determine the proper length, depth, and distance apart of furrows in order to produce maximum yields with minimum quantities of water. The investigations have shown that light early irrigation and heavy late irrigation tend to a light production of fodder or straw and a heavy production of seed, while heavy early irrigation and light late irrigation cause the reverse. The number of irrigations during a season have been found to have a very important bearing on the yield. In the irrigation of sugar beets it was found that merely by a better handling of the same quantity of water the sugar content was increased 2.1 per cent. Considerable work has also been done in peach and apple orchards to determine the effect of different quantities of water and different times of application on the growth of the trees and the growth of the fruit. In peach orchards it was found that the most rapid growth of the tree and the stone is made in the fore part of the season, while that of the peach is made in the last part of the season and liberal applications of water in late summer resulted in large yields. Prof. McLaughlin has recently prepared a Farmers' Bulletin on the Irrigation of Grain.¹

ARIZONA.

P. E. Fuller, located at Phoenix, has charge of the work in this State and also has general charge of investigations of power for irrigation throughout the West. His work in Arizona has consisted chiefly of giving personal advice to irrigators, especially in the installation of pumping plants. Mr. Fuller has prepared a Farmers' Bulletin on the Use of Windmills in Irrigation in the Semiarid West.²

NEW MEXICO.

F. L. Bixby has charge of this field in connection with work in the agricultural college. A careful study is being made of irrigation conditions throughout the Territory, and it has been found that the methods in practice for the most part are very crude. The chief work

¹ U. S. Dept. Agr., Farmers' Bul. 399.² U. S. Dept. Agr., Farmers' Bul. 394.

of our agent is therefore of an educational nature, to induce better and more economical methods of growing irrigated crops. Considerable areas in New Mexico are irrigated with pumped water, and data have been obtained regarding pumping plants which will be of value to those who contemplate installing new plants. Measurements have also been made on a number of canals to determine roughly the amount of water being applied by present wasteful methods and data have been collected showing the yields which have been obtained under such conditions. Experiments with evaporation tanks to determine losses of moisture from irrigated soil have been carried on at the New Mexico station for the past three years.

COLORADO.

The work in this State of late years has been largely experimental. A demonstration farm 40 acres in size is maintained at Eads under the direct charge of W. H. Lauck. The work consists in part of a comparison between dry farming and irrigation, the use of small supplies of pumped water as a supplement to dry farming, and the proper handling of the soil to prevent the damaging effects of high winds.

Experimental tracts are also maintained at Rockyford and Canon City, of which R. G. Hemphill is in charge. At Rockyford comparisons have been made with different methods of irrigating sugar beets, such as the every and alternate row irrigation, rapid and slow irrigation, and different number of irrigations. At Canon City the work has consisted of comparisons in a 4-acre apple orchard of clean cultivation and light irrigations versus intercropping and heavy irrigations. The results here seem to favor clean cultivation in bearing orchards.

WYOMING.

In this State the work has been confined to two experimental farms, one located at Cheyenne, under the direction of John H. Gordon, and the other at Newcastle, under the direction of R. E. Mahoney. The Cheyenne farm consists of 70 acres and was the first of its kind established by the office. The chief lines of work have been to demonstrate the advantage of having a small supplemental water supply as a supplement to dry farming and of utilizing the flow of streams during the winter months by irrigation in connection with thorough cultivation. Comparisons have been made of different types of wind-mills, and experiments with various materials suitable for lining small reservoirs have been made. The work at Newcastle is along practically the same lines as that at Cheyenne. Two circulars¹ have been published giving the results obtained at these two stations.

¹ U. S. Dept. Agr., Office Expt. Stas. Circs. 92, 95.

MONTANA.

Experiments to determine the losses of water from soil by evaporation have been carried on for the past three years in cooperation with the State experiment station at Bozeman. L. F. Geiseker has charge of this work.

NORTH DAKOTA.

Experiments similar to those described for Montana have been conducted in cooperation with the State experiment station at Williston, with E. G. Schollander in charge.

KANSAS.

The greater part of the irrigated land of Kansas is in the extreme western portion of the State in the Arkansas Valley. J. W. Longstreth is our agent in this territory, with headquarters at Lakin. He has investigated the present irrigation practice in the Arkansas Valley and in other sections of the State where irrigation is practiced and has made a special study of pumping plants, since fully one-half the irrigation is done with pumped water. Experiments have been conducted to determine the proper method of applying pumped water to sandy soils in order to secure a uniform distribution and prevent excessive losses by deep percolation. Small applications applied at frequent intervals seem to be the best method under such conditions.

Some good results have been secured by winter irrigation with ditch water and it is believed that, owing to the large flow in the Arkansas River during the winter months, considerable areas can be irrigated profitably in this way.

TEXAS.

W. L. Rockwell is in charge of the work in this State, with headquarters at San Antonio. Rapid development is being made in irrigation and consequently large areas are being put under cultivation by farmers unfamiliar with irrigation practice. Our agent has therefore devoted the greater part of his time to visiting the sections where irrigation is practiced and giving advice to new settlers. In some of the older irrigated sections very crude and wasteful methods are employed and he is endeavoring to bring about a reform in these methods which will result in extending the irrigated area and increasing the crop returns. There are a large number of pumping plants in the State, and these are also being studied.

IRRIGATION OF RICE.

The investigation of irrigation problems in the rice districts of the South has been under the charge of Prof. W. B. Gregory, of Tulane University, New Orleans, for a number of years, who has divided his time between this office and the university. Owing to the increasing interest in rice growing and the many complex problems which have arisen, it has been found necessary to place another agent in the rice district who could devote his entire time to the work. C. G. Haskell has been given charge of this work with temporary headquarters at Stuttgart, Ark. The ravages of the boll weevil have made the growing of cotton less profitable than formerly and the farmers are turning to rice growing. This necessitates the installation of pumping plants, the building of levees, etc., and the cotton growers are usually entirely unfamiliar with such things. Prof. Gregory has recently prepared a circular¹ on the cost of installing small pumping plants which is designed to meet the needs of this class.

IRRIGATION IN HUMID SECTIONS.

Milo B. Williams is in charge of irrigation investigations in the Eastern and Southern States, where irrigation is practiced as an insurance in times of drought and for intensive farming of truck crops and small fruits. In some parts of Florida during the winter months the rainfall is frequently quite light and irrigation is practiced for the growing of truck and citrus crops. Considerable areas are also irrigated in the artesian region of Alabama and Georgia and to a limited extent in isolated sections in Maryland, New Jersey, Pennsylvania, New York, and a number of other States. The soil and climatic conditions in the East are so entirely different from those of the arid region that western methods of irrigation can not as a rule be followed. The principal methods employed at present are the overhead spray system and subirrigation from pipes, and our agent is devoting the greater part of his time to a study of these systems. It is highly desirable to find cheaper methods of applying water to the soil than those now in vogue, and it is believed that this can be accomplished when conditions are fully understood.

DRAINAGE INVESTIGATIONS.

There has been no material change in the scope or general conduct of the work pertaining to drainage investigations during the year, but the field has widened as public interest in agricultural drainage has increased. Investigations and surveys were made in twenty

¹ U. S. Dept. Agr., Office Expt. Stas. Circ. 101.

different States and Territories during the year by engineers of the office, some of the work being done in cooperation with local interests which contributed a part of the expense.

The chief of drainage investigations directs a regular staff of 25 office and field engineers and 2 draftsmen. The entire time of one engineer is given to the work of tile drainage in various parts of the humid region where special information and advice upon that subject are needed, and five are stationed in the Western States to study the problems which arise in attempts to drain irrigated lands and to assist the owners who desire to reclaim tracts which have become injured by seepage or by alkali. Other field engineers are employed in examining and reporting upon the status of drainage in various localities, such examinations being made upon special requests which are filed from time to time with the office. They are also charged with the duty of advising engineers, farmers, and others regarding the best practice in drainage, of collecting practical and technical data pertaining to methods of reclaiming land, of giving assistance to land owners in the organization of drainage districts, and of suggesting preliminary plans for reclaiming areas of farm lands or those subject to periodical overflow, all of which may be made useful for agriculture. The office engineers reply to inquiries received by mail concerning perplexing drainage problems. They also examine plans which are transmitted by mail or in person, and in many instances suggest improvements or modifications which are of great value. They review, check, and edit the reports prepared by the field engineers upon the various projects which they have worked out, and disseminate as far as practicable the information obtained by the entire staff of engineers.

Some of the special problems encountered in farm drainage are the rate of percolation of water through heavy, compact soils, such as buckshot and river-bottom silts, the proper drainage and conservation of moisture in peat and muck soils, the comparative value and economy of large tile drains as compared with open ditches under the various conditions of soil and of agricultural development, and the best and cheapest methods of constructing small ditches for water-courses and digging trenches for tile drains.

Problems connected with the drainage of irrigated land require a careful study of the movement of the ground water in order to develop practical and efficient methods of restoring injured lands to their former value for cropping purposes. Thorough investigations show that in some instances a single drain may intercept the underflow and prove efficient. In others it is found that several drains are required to properly reclaim the injured fields. The accumulation of alkali which results from seepage in many localities is a serious menace but is removed by draining the land which shows injury of

that kind. The assistance given to farmers in the far West by the office includes examinations and surveys of seeped lands made upon the request of the owners, and sometimes the supervision of the construction of the drains, as well as their design, in order that the methods of draining such land may be demonstrated for the benefit of localities where similar conditions prevail.

The technical data which the office endeavors to secure include measurements of run-off from drained areas and representative watersheds, measurements of the discharge from artificial drainage channels, the efficiency of drains in different soils, methods of regulating the moisture of peat and muck soils, a study of machinery which is adapted to the construction of levees and ditches of different kinds, and investigations of pumping plants for drainage purposes.

The assistance rendered in the inauguration of drainage works includes preliminary field examinations followed by oral or written reports to the people who are concerned in each project; surveys, upon request, of representative areas, and the preparation of working plans which are presented in a report accompanied by maps and other necessary drawings, together with estimates of cost; and consultation with engineers and commissioners of drainage districts regarding the effectiveness of drainage plans which are not prepared by the office. Where surveys are made, district authorities or local landowners sometimes pay a share of the cost. This enables the office to extend assistance to a larger number of fields than it otherwise would be able to do.

The work is being done under the immediate direction of C. G. Elliott, chief of drainage investigations, and may be classified and described under the following headings:

- (1) Improvement of farm lands now under cultivation.
- (2) Drainage of swamp lands.
- (3) Reclamation of land subject to frequent overflows from streams.
- (4) Drainage of irrigated lands.
- (5) Collection of general and technical data on drainage.
- (6) Preliminary and reconnoissance work.
- (7) Dissemination of information.

IMPROVEMENT OF FARM LANDS.

A survey was made of the Redden farms, comprising 740 acres, near Redden, Del., by L. L. Hidinger. Plans were prepared for a system of tile drains and open ditches for a part, including the improvement of the Mifflin Ditch, which is the outlet for the drainage of the larger part of the farm.

A survey was made, by J. R. Haswell, of the farm of William R. Marrs, near Hebbardsville, Ky., which contains about 300 acres,

more than 260 of which are cultivated, and combines the very rolling topography of the upland country with the wet draws of the flat bottom lands. A complete system of tile drains for the lowland was laid out, and also an experimental system for the hillsides, to test the value of underdrains for preventing erosion by the surplus water from the hills. The work of installing the drains will be started at once by Mr. Marrs, and the farm will serve as an excellent example of the efficiency of underdrainage for these purposes in the silt and clay loam soils of that region. An examination was made, without an instrumental survey, of Mrs. Adam Rankin's farm of 400 acres near Henderson, Ky. A report was prepared outlining the drainage needed for those lands.

L. L. Hidinger made a survey of the farm of the Princess Anne Academy, a school for colored people near Princess Anne, Md., used as the eastern branch of the Maryland Agricultural College. A plan was prepared for a system of tile lines to drain about 106 acres, and instruction was given to the principal and local manager in the principles and practice of farm drainage, that they might be taught to the students. The engineer's assistants were pupils of the academy.

A survey of the Cumberland farm, consisting of 2,500 acres, near Portsmouth, Va., was made by George R. Boyd. The system of ditches that had been constructed by the owners of the farm had not given the desired efficiency, and plans were made for improving the drainage by modifying the old system, and by the construction of some new ditches and a low levee to intercept the water flowing from adjacent higher land as well as to remove more promptly that falling upon the farm. The owner at once purchased machinery and began the construction work recommended.

A system of tile drains was arranged for about 50 acres of wet land on the farm of John A. Bechtel, near Williamsburg, Va. Notwithstanding the fact that this tract occupies a high elevation, careful artificial drainage is required.

The Arkansas State Normal School acquired a farm of 80 acres to encourage the teachers of the State to become familiar with the principles of scientific farming. F. F. Shafer made a survey of the farm and prepared plans in detail for a tile system to drain 25 acres of the farm that are too wet for cultivation.

Old rice lands on the farm of J. F. Shoemaker, near Crowley, La., have been abandoned for rice growing, and rotation of crops is needed to restore their fertility. To permit this change in cultivation, especially in the very close soil of such land, the drainage must be carefully planned. A. M. Shaw made a survey of 210 acres of these lands, and laid out farm ditches in such a manner that after a few years the land can again be made suitable, at small expense, for growing rice.

DRAINAGE OF SWAMP LANDS.

Along the coast of the South Atlantic States are considerable tracts once devoted to the production of rice, but now abandoned because this crop can no longer be raised profitably in competition with that from lands more favorably situated. It would be of value to know whether such lands can be economically drained and cultivated to dry-land crops. Surveys and plans were made by George M. Warren and D. L. Yarnell for draining 340 acres of such land on the Orton plantation and the Garrell tract, near Wilmington, N. C. The construction of levees, the excavation of ditches, and the installation of pumping plants seem the most practicable method of reclamation.

Near Belvidere, N. C., is a tract of 3,500 acres, which the owners have attempted to drain by ditches without success, owing largely to lack of proper outlets. George R. Boyd made a survey of the tract and reported the changes and additions that should be made to the old ditch system.

A survey was made by J. V. Phillips of about 2,200 acres in Washington, Hyde, and Beaufort Counties, N. C., drained by the Pungo River. The river channel has not sufficient capacity to remove the water promptly. A new main outlet ditch was planned, following the river channel closely, the location for the ditch was marked in the field, and the size and approximate cost were determined.

The area drained by the Scuppernong River, including the watershed of Lake Phelps, in Washington and Tyrrell Counties, N. C., was surveyed by George R. Boyd. Plans were made for enlarging the river channel and extending it to Lake Phelps; for the construction of new drainage ditches and the enlargement of some of those previously constructed; and for the control of the lake to prevent overflow. The construction of the work which has been recommended will benefit 75,000 acres.

A watershed survey of the territory between Albemarle and Pamlico Sounds in Beaufort and Washington Counties, N. C., was made by George R. Boyd, assisted by J. V. Phillips and F. G. Eason, the John L. Roper Lumber Co. paying one-half the cost. The survey established the natural watershed lines in this area, and connected the surveys in these counties and that of the Lake Mattamuskeet project in Hyde County, previously made by this office. The approximate area is 158,000 acres, exclusive of that in the territory covered by earlier projects. A new ditch was located along Broad Creek, in the southwest part of the district, to furnish an outlet for 19,500 acres. The location was determined also for a main ditch to drain 36,300 acres in the northwest part of the district and discharging into Conaby Creek near Plymouth.

D. L. Yarnell made a survey of a tract near Norfolk, Va., known as Berkeley Swamp, which borders the Great Dismal Swamp. A

system of ditches was planned to drain about 2,400 acres of this wet land.

Contracts have been let during the summer of 1910 for the construction of the drainage improvements planned by this office in 1908 for reclaiming swamp lands in Bolivar County, Miss. S. H. McCrory assisted the engineer of the district in preparing specifications for the work.

The board of commissioners of the Tallahatchie drainage district, in northwest Mississippi, requested this office to lend assistance in perfecting the plans for draining that area of 1,800 square miles by sending an engineer to act in a consulting capacity. Drainage engineers of this office are especially acquainted with the conditions of that district, having previously made surveys of parts of the territory. A. E. Morgan examined the plans and the district in detail, and thoroughly studied the methods that seemed feasible. His suggestion to divert Cold Water River through a shorter route into the Mississippi River has been adopted by the commissioners and engineers.

RECLAMATION OF OVERFLOWED LANDS.

The flat bottom lands between the Black River and Cury Creek, in Independence County, Ark., are subject to frequent overflow from those streams. A survey was made of the lands, and plans were prepared by W. J. McEathron and W. W. Weir for protecting about 14,000 acres. The plans include the construction of levees to prevent overflow from Black River; the diversion of Cury Creek by a new channel from the foothills directly across the bottoms to the river; and the excavation of a ditch to intercept the water that now flows upon the low area from the higher land on the west.

S. H. McCrory and D. L. Yarnell conducted a survey of about 140 miles of the Marais des Cygnes River, west from the Missouri-Kansas State line, to determine some method for preventing the injurious flooding of the bottom lands. The report upon that project presents plans for 22 levee districts, which will protect 33,365 acres of fertile land if the recommended work, including that of clearing the river channel and constructing one cut-off, is carried out.

A survey was made by W. W. Weir of lands subject to overflow along the Little Caney River in Montgomery and Chautauqua Counties, Kans. Owing to the hilly character of the upper watershed, the rate of run-off is large, and the tortuous and restricted channel of the river has so little capacity that serious floods are of frequent occurrence. Plans were prepared for levees, a large relief ditch, several cut-offs, and clearing the river channel, to benefit 8,435 acres.

A survey was made by L. L. Hidinger to determine what works should be constructed to protect and drain the lands in Grant Town-

ship, about Lawrence, Kans., that are subject to overflow from the Kansas River. A levee was planned along the river, and drainage ditches within the district, the construction of which will reclaim and improve 7,500 acres of valuable land.

The Sellars ditch, near Henderson, Ky., is a cut-off 1 mile long on Canoe Creek, that does not fulfill its purpose of preventing the flooding of the bottom lands. A survey was made of this ditch by J. R. Haswell, who prepared recommendations for constructing a diversion dam in the creek at the head of the ditch, and for enlarging this channel so that it and the creek will provide a sufficient outlet for the drainage basin which has an area of 13,750 acres.

Investigations were made and a preliminary report prepared by C. G. Elliott, A. E. Morgan, S. H. McCrory, and L. L. Hidinger on the drainage of the fifth Louisiana levee district.¹ The area comprises 1,562,000 acres in the northeast part of the State, of which not more than 300,000 acres are cultivated, the balance being woodland. Very nearly the whole area suffers from lack of drainage, owing to the flatness of the country and to the crooked and obstructed character of the natural streams. The report outlines the necessary work for providing the required main drainage systems, the lateral drains, and the levees, and gives an approximate estimate of the cost of this work, besides making recommendations concerning drainage organizations and suggesting methods of conducting a complete survey of the district.

In Johnson County, Nebr., the bottom lands along the Nemaha River have been overflowed so frequently in the past few years that their cultivation has become quite hazardous, and about 2,500 acres formerly cultivated have been abandoned. A survey of the lands was made by F. F. Shafer, and a plan was prepared showing the ditches and other improvements which would be necessary to protect from overflow about 13,000 acres in the valley.

The overflowed lands along Wahoo Creek, in Saunders County, Nebr., were surveyed for drainage purposes. A large ditch was designed by W. J. McEathron to assist the creek in carrying away the water from the upper part of the drainage basin and to provide a good main drain for the low farm lands from which the water does not flow readily into the creek. In the upper part of the valley cut-offs are planned to shorten the creek channel and increase its capacity. These works when constructed will benefit more than 16,000 acres.

A report was prepared by A. D. Morehouse, based upon a preliminary examination by L. L. Hidinger and data from local surveyors, for improving the channel of Lower Creek, in Burke and Caldwell Counties, N. C. The work recommended is the enlarge-

¹ U. S. Dept. Agr., Office Expt. Stas, Circ. 104.

ment of the creek channel, to prevent the flooding of some 2,600 acres. The Lower Creek drainage commissioners have made plans to undertake the work at once.

The Deep Fork of Canadian River, in Oklahoma, is typical of many streams in that and neighboring States. The precipitous character of the watershed area causes a high rate of run-off, and the crooked channel of the river has insufficient capacity for removing the water as quickly as it gathers in the valley. The consequent overflows can be prevented only at considerable expense. A survey was made by F. F. Shafer and F. G. Eason to determine whether it would be feasible to undertake the reclamation of the inundated lands on this river in Lincoln and in Okmulgee Counties. In the former county a straightened channel was located and its proper size was determined; in the latter, eight levee districts were planned. Estimates of cost were made for these improvements, which would benefit 26,600 acres in Lincoln County and 11,740 acres in Okmulgee County.

A survey was made of bottom lands along the Big Sioux River, in Iowa and South Dakota, by F. F. Shafer, to determine the best plan for preventing the inundation of these lands during periods of floods in the river. The construction of levees and of cut-offs to shorten the river channel have been planned to protect 5,100 acres in Iowa and 6,595 acres in South Dakota.

In accordance with a cooperative agreement between this office and the State geological survey of Tennessee, an extended examination was made by A. E. Morgan and S. H. McCrory of the lands overflowed by the North and Middle Forks of Forked Deer River and Rutherford Fork of Obion River, in Gibson County, Tenn. A general plan for the drainage of these lands was made, with an outline for the survey that must precede the construction of the drainage improvements.

L. L. Hidingier examined the plans made for the Ellis County drainage district No. 1, near Waxahachie, Tex., and reported to the officers of the district concerning the efficiency of the plans and the improvements that might be made in them for reclaiming the lands from the overflow of Chambers Creek.

W. J. McEathron consulted with the commissioners of a drainage district formed to protect 70,000 acres of overflowed land in White County, Ark., lying between the White and the Red Rivers. His report gives advice concerning the conduct of the survey then in progress and the planning of the drainage improvements to be made.

The assistance of this office was requested in perfecting the plans for protecting from overflow the low bottom lands about Pattonsburg, Mo. An examination of the district was made by L. L. Hidingier, who reported a general plan for the work that would be necessary.

W. J. McEathron responded to the request of residents of the Elkhorn Valley for advice in protecting their overflowed lands by visiting the district and outlining a general drainage plan.

The engineer and commissioners of the Inlet Swamp drainage district, in Lee County, Ill., requested assistance in revising the plans for that district. The area of 30,000 acres was at one time a swamp, but ditches have been constructed that have effected partial drainage. W. J. McEathron examined the district and the plans, and recommended changes to reduce the cost of the work necessary to complete the reclamation of the land.

DRAINAGE OF IRRIGATED LANDS.

The investigations in Texas begun by L. L. Hidinger in March, 1909, were continued until the fall of that year. A survey was made of the Ohio and Texas Sugar Co.'s plantation of 1,885 acres near Brownsville, and a plan for the drainage was prepared. Tile drains were planned for a badly seeped area of 18 acres; also for an experimental tract of 30 acres, to determine the proper spacing of underdrains in certain soils of the Brownsville region. A survey and a plan for tile drainage were made for 105 acres damaged by seepage and alkali on the Val Verde Irrigation Co.'s farm near Del Rio. The owners of this property are desirous of undertaking at once such works as are necessary to remove the salts and excess water from the tract and to prevent injury to other areas. Many places were visited in the Rio Grande and Pecos River Valleys, farm lands being examined and suggestions given regarding the proper methods of draining and of removing the salts when such are present in the soil to an injurious degree. A report upon The Drainage Situation in the Lower Rio Grande Valley, Tex.,¹ has been prepared for distribution.

Investigations in the Pecos River Valley in New Mexico were begun in April, 1910, by Sidney W. Cooper, to assist and instruct owners in reclaiming their lands that are injured by seepage and alkali. Examinations have been made of tracts near Dexter, Roswell, Hagerman, and Artesia.

In the Big Horn Valley, Wyo., investigations were begun by W. A. Kelly, who has examined areas needing drainage in the vicinity of Lovell, Cowley, Byron, and Burlington.

With headquarters at North Yakima, Wash., J. C. Carpenter has begun investigations of irrigated lands injured by seepage and alkali in the Yakima River Valley.

The work in Utah and Colorado has been continued throughout the year by C. F. Brown, R. A. Hart, D. G. Miller, and H. R. Elliott. A plane table survey of a considerable tract near Oasis and Hinckley,

¹ U. S. Dept. Agr., Office Expt. Stas. Circ. 103.

Utah, was made to map the areas of land injured by seepage and alkali in this district. Further assistance has been given in the construction of extensions to the drains previously installed on the Geary tract at Huntington, and the Washington field at St. George, Utah. The extensions on the Geary tract have been completed, but those at St. George have been delayed by unfavorable weather and by the irrigation of adjacent higher lands. Many other examinations have been made in this State, including a survey and the design of a drainage system for the farm of G. D. Williams, near Syracuse. The drains on the Jensen tract, near Murray, have been installed under the supervision of Mr. Hart.

In Colorado, examinations and surveys were made of various tracts in the valleys of the Grand, Gunnison, and Uncompahgre Rivers, and assistance was given in the installation of drains. A survey was made of 3,600 acres near Parma, in the San Luis Valley, and plans for the drainage of the tract were prepared. Plans were also prepared for the Arnell tract of 3,000 acres in the same valley, and assistance was given in the organization of the La Jara and Hooper drainage districts.

C. G. Elliott visited the Yakima Indian Reservation, Wash., to confer with the chief engineer of the Indian Bureau concerning the plans for the drainage of the lands injured by seepage and alkali on that reservation.

COLLECTION OF TECHNICAL DATA.

A series of experiments was made in Florida by H. A. Kipp and F. F. Shafer to determine the maximum and the optimum moisture contents of muck soils and the amount of water that should be removed from saturated muck to bring it into good condition for crop growth. From five tracts near Kissimmee, one tract near Miami, and seven near Fort Lauderdale, a total of 121 samples were taken, both of raw and of cultivated soils. Five weeks were required for testing the samples. Experiments to determine the moisture content of saturated muck soils of the wet prairie lands of southern Louisiana, and the amount of water in the soils when they are in good condition for cultivation, were made by C. W. Okey on tracts near Lockport and Raceland. These investigations furnish data of much value in determining how thoroughly such soils should be drained, also in estimating the storage capacity of the ground and its effect upon the maximum rate of run-off to be used in planning drainage systems.

The investigations of run-off in southern Louisiana, begun in the spring of 1909, were continued until the end of May, 1910, by A. M. Shaw and C. W. Okey. Tests of pumping plants and some gagings of flow in ditches were made; records were obtained of the periods

during which the pumps were operated, with the quantities of water removed, and the rise of the water table in the soil after storms was observed as it was indicated by the elevation of the water in the ditches. In connection with these investigations data were obtained concerning the tropical storm of September, 1909, particularly the height to which the water was raised along the Gulf coast, which seems to be above any high-water records obtained during the last 100 years. The frequency and severity of storms that raise the water level along the coast above the normal water level will affect materially the drainage of considerable areas in the southern part of this and neighboring States.

The examinations of drained tidal marshes were continued by George M. Warren. Reports have been prepared on lands of the Arthur Colburn estate, of the St. Georges Marsh Co., and on the Little St. Georges and St. Augustine marshes, in Newcastle County, Del.; also on the lands of the Mauricetown Banking Co. and other tidal marshes in Cumberland County, N. J.

A study of improved methods of excavation, as used in digging the New York Barge Canal, was made by A. E. Morgan. The information obtained related to the kinds and arrangements of the machinery, the class of work to which each kind is adapted, the advantages and limitations of the various types, and the cost of work done by each. This information was obtained by consulting the designers and the operators of the machines, and by a thorough personal examination of the excavators in operation.

PRELIMINARY AND RECONNOISSANCE WORK.

Other than the work included in the projects already enumerated, a large number of examinations of a preliminary or reconnoissance nature have been made. The purpose of these is to offer helpful suggestions to people wishing assistance in undertaking drainage improvements, or to obtain information concerning the status of drainage in various localities. Areas covered by the more important of such investigations are the following:

Swamp lands along the Cache River, in Illinois; Nahunta and Turnbull swamps, in North Carolina; wet and overflowed lands along various streams in Pasquotauk, Perquimans, Rockingham, Iredell, Rowan, Robeson, Cabarrus, and Forsyth Counties, N. C.; overflowed lands on Big Spring Creek, near Huntsville, Ala.; lands overflowed by the Verdigris and Falls Rivers, Kans.; overflowed lands on Black Bear Creek, Okla.; overflowed lands on the Red, Sulphur, Brazos, Elm Fork, and Trinity Rivers, Tex.; examinations of drainage needs in Bryan, Chatham, Clinch, Echols, Glynn, Liberty, and McIntosh Counties, Ga.

DISSEMINATION OF INFORMATION.

Much general information is disseminated by correspondence, and the reports upon the various projects contain much that is of general as well as special application. Further information is given by addresses and lectures at conventions to those interested in the general subject of agricultural drainage and at meetings of land-owners wishing to undertake the drainage of particular tracts of land.

Publications issued during the fiscal year 1910, relating to agricultural drainage, are as follows: The Drainage of Irrigated Lands in the San Joaquin Valley, Cal. (Office of Experiment Stations Bulletin 217); Drainage of Irrigated Lands (Farmers' Bulletin 371); Preliminary Report on the St. Francis Valley Drainage Project in Northeastern Arkansas (Office of Experiment Stations Circular 86); Organization, Work, and Publications of Drainage Investigations (Office of Experiment Stations Circular 88); Reclamation of the Southern Louisiana Wet Prairie Lands (Office of Experiment Stations Document 1315); and Preliminary Report upon the Drainage of the Lands Overflowed by the North and Middle Forks of the Forked Deer River and the Rutherford Fork of the Obion River in Gibson County, Tenn. (issued in cooperation with the State Geological Survey of Tennessee).

PROMOTION OF AGRICULTURAL EDUCATION.

In the year 1910 the movement for the promotion of agricultural education was world-wide. As will be seen from the detailed report of the specialist in agricultural education of this office (pp. 315-386), agricultural colleges and schools were established or other projects in agricultural education were inaugurated in Africa, in Australia, Canada, and several other countries in the British Empire, in China, Finland, France, Germany, Japan, Mexico, and several countries in South America.

In the United States the number of institutions listed by the office as teaching agriculture increased from 545 in October, 1908, to 875 in May, 1910, a gain of 330, or more than 60 per cent, in 19 months.

The agricultural colleges again surpassed all previous records in the number of students enrolled and in the number taking courses in agriculture. There were 10 per cent more students in agriculture than in 1909 and more than eight times as many students enrolled in teachers' courses in agriculture. Forty-six of the agricultural colleges maintained teacher-training courses in agriculture. In more than half of these institutions the teachers' courses are four years in length, and in 29 of them summer schools for teachers were held. The income of these institutions was larger by three and one-half millions than in 1909, and they added more than seven millions to their permanent endowment and equipment. Important agriculture and

science buildings were completed in Alabama, Massachusetts, New Mexico, North Dakota, and Indiana.

The number of secondary schools teaching agriculture (including colleges offering secondary courses) was 630, and the number of normal schools and colleges conducting teacher-training courses in agriculture, 214. There were 58 agricultural schools and 28 public high schools receiving State aid for agriculture, 432 unaided public and private high schools and academies, 46 secondary schools for negroes, and several colleges and schools on private foundations. Extension work and short courses were successfully conducted by a number of the high schools and also by normal schools. Thirty-six colleges and universities in the United States now give entrance credit for high-school agriculture.

As in former years, the most effective agricultural teaching in the elementary schools has been done where the classroom instruction has been combined with some form of competition, such as boys' corn clubs, potato clubs, and poultry clubs, and girls' domestic-science clubs and canning clubs. In the South several of the agricultural colleges have cooperated with this department in employing school-extension agents. The number of boys engaged in corn-growing contests under the joint auspices of these colleges and this department was this year (1910) more than 46,000.

The rapid progress in all phases of agricultural education has naturally resulted in heavy demands upon the United States Department of Agriculture. All bureaus of the department have felt this, and particularly the Office of Experiment Stations, which has continued to act as the general agent of the department for the promotion of agricultural education. The director, as the official representative of the department in its relations with the Association of American Agricultural Colleges and Experiment Stations, has taken an active part in all the plans of the department and the association for promoting graduate, collegiate, secondary, and elementary courses in agriculture and home economics. He has continued to act as bibliographer of the association and as chairman of its committee on instruction in agriculture, and has accepted the deanship of the fourth session of the Graduate School of Agriculture.

The agricultural education service of the office has continued to be under the immediate direction of Mr. D. J. Crosby, who has had the assistance of Mr. F. W. Howe as assistant in agricultural education and of several clerical assistants. Gratifying progress was made in the preparation of publications for the use of teachers and in the study of some of the many problems arising in connection with the rapidly developing movement for instruction in agriculture. The rapidity of this development and the consequent heavier demands upon the agricultural education service for publications and for advice concerning teachers, courses of study, equipment, methods of

instruction, and, in general, the relation of their work to the practical problems involved in agricultural production and the satisfactory development of home and social life in rural communities, prevented any great deviation from the policy of previous years. There has been, as formerly, clearing-house work for these institutions, cooperation with them and with associations representing their interests, and expert services in connection with the inauguration of new agricultural educational institutions, courses, and projects.

The specialist in agricultural education and his assistant have attended many conferences and large educational gatherings and have assisted school officers and teachers in many ways through correspondence and personal advice. The agricultural education service has also occasionally employed other experts of the office and experts from other bureaus to give addresses and to render technical assistance to agricultural schools, and would employ this very effective method more freely if funds for travel were available. Cooperation with other bureaus of the department has also taken form in the preparation of educational bulletins and circulars. One circular prepared in the Forest Service has been published, and a bulletin on rural school consolidation, prepared by a special agent of the Bureau of Statistics, has recently come from the press. Cooperation along these and other similar lines might well be extended, with resulting great benefit to the colleges and schools that are endeavoring to carry in an effective way to the people living upon the land the results of investigation on the part of this department and the State agricultural experiment stations.

FARMERS' INSTITUTES AND EXTENSION WORK.

The work of the office of the farmers' institute specialist during the year was in the direction of securing information respecting the condition and progress of farmers' institutes and agricultural extension in this country and abroad, conducting correspondence, and in preparing copy and editing for publication bulletins, circulars, and reports upon farmers' institute and agricultural extension work.

Farmers' institutes were held in all of the States and Territories excepting New Mexico, Nevada, Alaska, and Hawaii. The total number of regular institutes was 5,651; these were made up of 3,539 one-day meetings, 1,940 two-day, and 172 three-day or more. The whole number of days of institutes in 1910 was 7,935, an increase of 801 over 1909, and the number of sessions held was 16,586, or 1,051 more than the previous year. The attendance reported at all of the regular sessions was 2,395,908, and the average attendance at each session was 144. The appropriations from all sources amounted to \$432,374.25, or \$86,707.76 more than in 1909. The agricultural colleges and experiment stations furnished 480 lecturers from their faculties and station staffs for institute service, representing the

agricultural colleges and experiment stations in 43 States. Thirty-nine of the States and Territories report the days of service contributed by their lecturers at 4,780, an increase of 21 lecturers over the number furnished in 1909 and 1,399 more days of service.

In addition to carrying on the work of the regular institutes the States have been maintaining a number of special meetings of institute character. Of the various forms of institute activity the movable school of agriculture is perhaps most promising. Four hundred and twenty-three sessions of these schools were held, attended by 65,977 persons. Special subject institutes, round-up meetings, picnics and harvest-home meetings, field demonstrations, women's institutes, institutes for young people, agricultural instruction trains, and other forms of institute activity were reported with an aggregate attendance of 537,336, making the total attendance of all kinds for the year 2,933,244, an increase of 74,365 over the year before.

Cooperation with the agricultural colleges in their extension work has been continued. The reports received by the institute office show that extension departments have been organized in these colleges in 32 States and Territories by 35 institutions, and that in 3 other States departments have been partially organized. One hundred and thirteen persons were employed during the year for their full time in extension work in connection with the colleges and stations, and 189 other persons contributed part of their time. The appropriations for carrying on the work amounted to over \$400,000.

The farmers' institute specialist has been acting also as secretary of the American Association of Farmers' Institute Workers. This organization held its fifteenth annual meeting in Washington, D. C., last November. At this meeting there were representatives from 37 States, the District of Columbia, and three of the Provinces of Canada. The sessions continued during two days. The principal lines of discussion were in the direction of establishing institutes for women separate from those for men, but in affiliation with the present institute system, and also in considering the propriety of establishing institutes for young people between the ages of 14 and 18 years. The discussions brought out the fact that institutes for women were being successfully conducted by a number of the States. The Province of Ontario, however, was the most notable example of organization of institutes of this character. Over 600 separate institute societies for women are already in operation in the Province of Ontario with an enrolled membership of over 16,000 persons. Five thousand four hundred and eighty-three sessions of women's institutes were held last year in that Province, with an attendance of 140,388.

As an outcome of the discussion of the organization of institutes for young people between the ages of 14 and 18 a resolution embodying the sense of the association was adopted recommending the several directors of farmers' institutes to make the experiment within

the next year of holding some institutes for young people. This new field of effort was recognized as belonging specially to the farmers' institute organization, and as being in great need of immediate attention. In aid of this movement the Office of Experiment Stations has published a circular entitled "Farmers' Institutes for Young People," in which suggestions are offered for organizing and conducting this kind of extension work. The papers, discussions, and reports of the standing committees of the association have been assembled by the institute specialist and prepared for publication.

The use of agricultural instruction trains is growing each succeeding year. Twenty-four of these trains were reported as having been run during the year ended June 30, 1910, by 18 States with an attendance of 189,645. An investigation now being made into this new method of disseminating agricultural information shows that the transportation companies have awakened to the possibilities for increasing agricultural production by this means, and are exerting themselves to bring about this increase as soon as practicable.

In response to inquiries sent out to over 3,000 local managers of farmers' institutes in 40 different States, information of most convincing character has been received showing approval of the movement for sending out movable schools of agriculture, and of the appointment of itinerant advisers and instructors to visit farmers and give them advice respecting improved and more economical methods in farm operations. Appreciation of the value of the itinerant adviser was specially emphasized. Of the whole number replying to this query, 698 were in favor of the itinerant adviser, 99 were undecided, and only 149 against the plan.

The institute specialist has cooperated with the American Association of Farmers' Institute Workers in the preparation of its programs, reporting its proceedings, and in preparing them for publication. He has also cooperated with the Association of American Agricultural Colleges and Experiment Stations in collecting and tabulating information for the use of the committee of the association on agricultural extension, and in conducting correspondence as secretary of that committee. He also took part in the program of exercises of the Graduate School of Agriculture at Ames, Iowa, and he and his assistant have attended and addressed various other meetings held in the interest of agricultural extension throughout the country.

The detailed report of the farmers' institute specialist will be found on pages 387-424 of this report.

PUBLICATIONS.

The publications of the office (1) review the progress of agricultural education and research throughout the world, and (2) report the results of special investigations with reference to nutrition, irrigation, drainage, and agricultural education, with which the office is

charged. To keep pace with the rapid increase of scientific literature relating to agriculture and to properly present the results of the special investigations conducted by the office it was necessary to increase to a marked extent the number and volume of publications issued by the office during the past year.

During the fiscal year ended June 30, 1910, the department published 86 documents, aggregating 4,824 pages, prepared by this office, not including revised reprints, separates, and minor miscellaneous publications. These documents include 20 numbers of Experiment Station Record, 12 technical bulletins, a report of the Alaska experiment stations, 2 reports of the office, 17 Farmers' Bulletins (including 5 numbers of Experiment Station Work), 17 circulars, 12 monthly lists of experiment station publications, 2 farmers' institute lectures, and 3 lists of publications of the office on irrigation, drainage, and agricultural education. Two other numbers of Experiment Station Record, 3 technical bulletins, 1 annual report of the office, 3 Farmers' Bulletins, 1 article for the Yearbook of the Department, and several miscellaneous documents containing about 1,050 pages were prepared and submitted for publication before the close of the fiscal year. Twelve separates of individual articles contained in larger reports, aggregating 436 pages, were reprinted in editions of varying size to supply requests for the articles. Several of the earlier technical and Farmers' Bulletins prepared by the office were exhausted during the year and were reprinted with additions and corrections.

In addition to the above, 2 reports and 5 bulletins of the Hawaii station and 2 reports and 3 bulletins of the Porto Rico station, although printed locally by the stations, were edited in the office.

The most important increases in the publication work of the office were in the case of Farmers' Bulletins, 17 of the 45 bulletins of this series printed by the department being contributed by the office, and in Experiment Station Record, of which 2 volumes were issued during the year instead of 1 as heretofore, each volume consisting of 6 monthly and 2 additional or abstract numbers, with the customary author and subject indexes. This plan of publication of the Record has the advantage of securing more prompt, complete, and convenient review of agricultural literature. The value of the Record as a great repository of information pertaining to agriculture otherwise available only by an extended examination of the enormous mass of literature which has been published is being more generally and fully realized. The 22 volumes thus far issued contain references to no fewer than 78,698 articles, besides editorials, special articles, and notes. The experiment station reports abstracted have alone numbered 914, the station bulletins and circulars 7,401, and the publications of this department 3,540. The vast store of agricultural information which the Record contains is made available by carefully prepared and very full indexes.

The increase in Farmers' Bulletins was due mainly to the fact that the various lines of investigation in nutrition, irrigation, drainage, and agricultural education carried on by the office have now reached a stage justifying wider popular presentation in the form of Farmers' Bulletins. In addition to Farmers' Bulletins of this class, the office continues its bimonthly review of progress in the more practical lines of investigation at the experiment stations in the Experiment Station Work series of Farmers' Bulletins. This series now comprises 63 numbers, each containing from 6 to 15 short condensed summaries of work done in one or more of the State experiment stations, and aggregating over 500 articles on subjects of interest to practical farmers. During recent years this series has increased in popularity, and there is every evidence that its value is quite generally appreciated by farmers.

The report of the Editor and Chief of the Division of Publications for the past year shows that of the 4,034,000 copies of publications of this office issued by the department 3,600,000 were Farmers' Bulletins.

The supervision of the work of preparing the publications of the office, in case of all publications except the Experiment Station Record, is one of the lines of work of Mr. W. H. Beal. The management of the Record is in direct charge of Dr. E. W. Allen, Assistant Director.

INCOME.

The income of the office during the past fiscal year, derived wholly from appropriations by Congress, was as follows:

For the general expenses of the office.....	\$74,060.00
For the Alaska experiment stations.....	28,000.00
For the Hawaii Experiment Station.....	28,000.00
For the Porto Rico Experiment Station.....	28,000.00
For the Guam Experiment Station.....	15,000.00
For investigations on agricultural schools and farmers' institutes.....	10,000.00
For nutrition investigations.....	10,000.00
For irrigation investigations.....	75,000.00
For drainage investigations.....	81,160.00
Total	349,220.00

In addition to the above there was derived from the sale of agricultural products at the insular experiment stations the following amounts:

Alaska experiment stations.....	\$741.42
Hawaii Experiment Station.....	33.40
Porto Rico Experiment Station.....	1,706.56
Guam Experiment Station.....	23.41
Total.....	2,504.79
Total income	351,724.79

WORK AND EXPENDITURES OF THE AGRICULTURAL EXPERIMENT STATIONS.

By E. W. ALLEN and J. I. SCHULTE.

REVIEW OF THE YEAR.

One of the most noteworthy features of the year has been the movement in the direction of a differentiation of experiment station work proper from the various features of extension work. The latter lines, including the issuing of popular bulletins, running of cooperative demonstration tests, operation of special trains, maintenance of a bureau of information, etc., which have largely developed with and out of the experiment station work, have now reached large proportions. It has been evident for several years that separate provision would need to be made for this enterprise, in order that the station men might devote themselves primarily to the work of experiment and investigation—i. e., the acquisition of knowledge and the maintenance of the fund of information on which the college instruction in agriculture and the extension teaching are very largely based. Material progress was made during the year in working out this differentiation in function, and in many States funds have now been provided which make this feasible.

The ruling of the office against the use of the Federal funds for defraying the expense of any of these forms of extension work, which went into effect with the beginning of the past fiscal year, has furnished a strong argument to the States for providing funds and facilities for it. In a number of States it has been organized under a separate head and in others has been taken over by the college. It has been difficult, however, for the stations, from the nature of their relations to agricultural advancement, to entirely escape the growing burden of extension teaching. In several of the States they are still intrusted with such work as is done, and the demand for it, even in the absence of any special funds, has required a closer scrutiny of all expenditures, and in several instances disallowances have been made. Under the present restrictions surrounding the Federal funds for the stations and the imperative demands within the States, the lack of a considerable State appropriation available for more general use has become a very serious embarrassment to an experiment station. The office has clearly differentiated the function of the experiment stations organized under the Federal acts, and during the past year has insisted upon the restriction of the expenditures from the Federal

funds to those directly connected with the conduct of actual experiments and investigations and the publishing of the results of these inquiries.

This action has been indorsed by the Association of American Agricultural Colleges and Experiment Stations. At the last convention of that association its committee on station organization and policy pointed out that—

There never was a time when the stations needed to be more circumspect and look more closely to their scientific reputation and even public appreciation than now. * * * To maintain a high and reliable grade of work is a principle incumbent upon all stations, not only for the general cause but for their own safety as well.

Neither the demonstration work nor the police work, it was urged, must be allowed to encroach upon the acquisition of knowledge, but there must be a clear distinction between propaganda and investigation, between the discovery of principles and the dissemination of their applications to practice.

The station administration must ever keep in mind that the reason for existence and the chief usefulness of the stations depend upon their keeping true to the main purpose for which they were established—the scientific investigation of the problems relating to agriculture.

With a better understanding of the necessity for fundamental studies in agriculture and the ultimate application of such investigations, the conditions surrounding such work have been improved and the opportunities for it materially strengthened. It has not always been realized that the principles underlying an agricultural problem must first be studied before the problem itself can be solved, and this has led to some public impatience with the methods of experiment which have been followed. The problems of agriculture are unusually intricate and involved, as they are affected by many conditions which are variable and not readily controlled. It is very easy, therefore, to draw unreliable conclusions or make unwarranted generalizations from a few local tests and experiments which do not disclose the factors which are in operation or the real nature and cause of the phenomena observed. Exact and reliable information for agricultural practice must rest on scientific investigations which are fundamental, and develop facts which are definitely proven and understood. There is much encouragement in the present attitude toward such investigation.

But in providing for this fundamental research the need of more practical experiments for local conditions and the application or adaptation of methods and crops to particular localities has not been lost sight of. Special provision for such enterprises has increased, special appropriations being made for particular lines of work and for the maintenance of branch stations. In California the university

and station came into possession of the new farm at Fresno, known as the Kearney estate, which includes 5,400 acres, with fine buildings, and is valued at about \$1,000,000. This was the gift of Mr. M. T. Kearney, and affords unusual facilities for experiments of interest to the San Joaquin Valley. In the Imperial Valley of California a substation was operated with a State appropriation of \$6,000 for the biennium. The climatic and other conditions are so different in this valley from other parts of the State as to afford opportunity for work of great usefulness.

In Idaho three branch stations have been provided for, their work to be directed to the study and demonstration of local problems. One of these has been located at Clagstone, in the cut-over district of northern Idaho, where a tract of 200 acres was contributed by an individual for the use of the substation. Another station for work in irrigation was located at Gooding, in southern Idaho, and work there successfully inaugurated. The third station, for dry farming, was located at Idaho Falls. The substation at Caldwell, which has been in operation for several years, is continued. Cooperative experiments with the fruit, dairy, and grain farmers of southern Idaho are being planned. The appointment of three field men for extension work in horticulture and entomology, irrigation and general farming, and dairying has been authorized.

Minnesota has made generous provision for this popular effort. The various divisions of the station are provided with funds for field and demonstration work from the current expense appropriations of the university, or by special appropriations for specific cases. The division of dairying and animal husbandry, for instance, has a fund of \$2,500 a year for special investigations in dairying and poultry lines, the division of entomology \$5,000 for field work in entomology, the veterinary division \$2,000 for hog-cholera work, the chemical division \$1,000 for soil investigations, the agricultural engineering division \$2,000 for drainage investigation and demonstration, the division of botany and plant pathology \$4,000 for plant diseases and \$1,000 for the eradication of noxious weeds, and the agricultural division \$2,000 for tobacco culture.

The engineering division of the Minnesota college and station supervised the drainage of an 80-acre demonstration farm at Belleplaine, Minn., and installed a small tile drainage experiment on heavy clay lands at Meadow Lands, Minn. Field work was also conducted in some of the potato-growing districts, consisting of lectures, demonstrations, etc., with the idea of getting the potato growers interested in better seed selection and cultural methods. These demonstrations were all well attended and proved of value. The outside corn-breeding stations were continued, and proved to be important as trial stations as well as for developing new varieties of corn adapted to

restricted localities. While no varieties were originated at these stations, the local varieties superior for each locality were discovered and new ones were introduced where conditions seemed to justify it.

In addition to these funds a special appropriation of \$50,000 for the biennium was granted by the legislature for extension and demonstration work and a correspondence course in agriculture. This has enabled the organization of a special extension division, which cooperates with the different divisions of the station and in all kinds of extension work. Among other duties laid down for this division is the publication of home-education bulletins, which are to give in plain and practical form the results of investigations of the State experiment station and the substations of the university.

Twenty demonstration farms, scattered throughout the State, are conducted by the extension division with the cooperation of the agricultural and other divisions of the station. Each farm is surveyed by soil experts, drainage maps are supplied where necessary by the engineering force, and cropping systems and farm organization are supplied by the division of agriculture and farm management. The station furnishes the advice and the direction and the farm pays all the bills. The results so far secured promise success for the movement. The university and station cooperated in exhibits and demonstrations at the State fair. A special feature was the lectures illustrated by moving pictures.

In Montana the Fort Ellis Reservation of 640 acres was turned over to the custody of the experiment station for experiments in dry farming. At the substation in Fergus County \$5,000 was invested in improvements and buildings, and for the horticultural substation in the Bitter Root Valley \$2,000 was allowed for buildings.

Two additional county demonstration farms were organized in Missouri during the year under the act of 1907, one at Clayton, in St. Louis County, and the other near Lewiston, in Lewis County. The chief lines of work undertaken were the testing of corn, wheat, and oats, with some attention to fertilizer and soil fertility experiments.

In Nebraska progress was made in the equipment of the new substations located at Mitchell and Valentine. At Mitchell special attention is to be given to work in irrigation and dry-land agriculture, and experiments will be conducted in cooperation with the Bureau of Plant Industry of this department. The land and a portion of the improvements were furnished by the United States Reclamation Service. The Valentine substation is to study the crops and agricultural methods adapted to the sand-hill region of the State.

North Dakota has five substations, with a State appropriation of \$5,000 each, and 24 demonstration farms which are provided for in a continuing appropriation. The work on the latter is largely rotation experiments, with some trials of new crops. These farms have

been very popular and helpful. They are supervised by two men who are kept in the field continuously and visit them at frequent intervals. Farmers' institutes and picnics were held at several of them during the summer.

Under an act passed in Ohio in the spring of 1910, the commissioners of each county are required, upon petition of 200 or more taxpayers, to submit to a vote a project for establishing a demonstration farm. If such a farm is decided upon, a tax not to exceed one-fifth mill for any one year may be levied for its equipment and maintenance. The experiment station at Wooster is to cooperate in the selection of sites and the conducting of experiments.

The Rhode Island station has inaugurated a series of cooperative experiments with farmers through the State, which are largely in the nature of demonstrations. The station now has about 150 of these cooperative experiments under way, the cooperators being organized into an experimental union which holds an annual meeting for the discussion of the results of the experiments.

Seven new substations authorized by the last Legislature of Texas were located during the year as follows: At Pecos in Reeves County, at Lubbock in Lubbock County, at Spur in Dickens County, at Denton in Denton County, at Temple in Bell County, at Beaumont in Jefferson County, and at Angleton in Brazoria County. The last two named are to give special attention to rice problems. The localities in which the several stations are situated have contributed liberally for their establishment, in some cases donating the land and erecting the necessary buildings and improvements.

An experiment station was organized under the auspices of the Association of Sugar and Sugar-Cane Producers of Porto Rico. The association, formed in 1909, is financed by a tax of 25 cents on each ton of sugar refined, or $2\frac{1}{2}$ cents for each ton of cane produced. The agricultural committee of the association has for one of its duties the establishment of model farms, experiment stations, and a technical sugar school. J. T. Crawley, former director of the Cuban station, has been selected as director of the station, and it is planned to secure a plant pathologist and entomologist and a field expert. D. W. May, special agent in charge of the Porto Rico Federal station, was appointed an honorary member of the agricultural committee and is acting in an advisory capacity to the station.

The Washington station has an appropriation of \$17,500 for extension work, and \$2,500 for dry farming. With these appropriations it conducts two branch stations and maintains a considerable number of demonstration farms which are conducted on the farms of private owners.

The Wisconsin station has 25 county and asylum farms (all State or county institutions) under its management. These are made local

centers for supplying farmers with seed grains, for demonstrations of better management, etc. Meetings are held on the demonstration farms during the season. The station also had 1,600 pedigreed-barley centers the past year, where enough seed was sent to grow an acre of the improved seed, for purposes of distributing it.

Provision has been made in Wyoming for dry-farming demonstrations by an appropriation of \$5,000, the adaptability of soil and climate for the production of different classes of grains and grasses, and for the growth of shade, ornamental, and fruit trees under Wyoming conditions to receive special attention.

Seed-testing laboratories for testing seed for farmers have been located at several of the experiment stations by the Department of Agriculture, and are conducted in cooperation with the stations

CHANGES IN PERSONNEL.

The year was marked by important changes at several of the stations, in a number of which the welfare of the institution was temporarily involved.

Prof. C. H. Fernald, for 24 years entomologist of the Massachusetts station, and for many years previous connected with the Maine Agricultural College, retired from active duties in the station and the graduate school of the college, being succeeded by Dr. H. T. Fernald; and at the Michigan college and station Dr. W. J. Beal retired after 40 years of continuous service as botanist, being succeeded by Dr. E. A. Bessey, of the University of Louisiana.

Prof. Harry Snyder, for many years in charge of agricultural chemistry at the Minnesota University and station, resigned during the year to engage in commercial work.

Prof. W. L. Carlyle, formerly of the Colorado college and station, was appointed director of the Idaho station, and entered upon his duties January 1, 1910. Prof. C. P. Gillette, entomologist of the Colorado station, was appointed director to succeed Prof. L. G. Carpenter, resigned; and in New Hampshire Prof. J. C. Kendall, of the Kansas college and station, was appointed director of the station and entered upon his duties September 10. J. W. Fox succeeded W. L. Hutchinson as director of the Mississippi station, and Prof. H. G. Knight was appointed director of the Wyoming station, vice J. D. Towar.

The necrology list is an unusually long one. It includes two notable figures in the history of agricultural education and research in this country—Dr. Charles A. Goessmann, of Massachusetts, and Dr. William H. Brewer, of Connecticut, who passed away soon after the close of the year. Notices of these two men are given hereafter. Col. W. M. Liggett, who retired from the position of dean and

director of the Minnesota College of Agriculture and station in 1907, died August 29, 1909; Prof. J. S. Newman, prominently connected with the Alabama and South Carolina stations, having served as director of the latter station at two periods, died May 11, 1910; and Prof. John A. Craig, lately director of the Oklahoma station and formerly connected with the departments of animal husbandry in Wisconsin, Iowa, and Texas, died August 9, 1910. Other deaths included Prof. A. J. Bondurant, formerly agriculturist at the Alabama station and professor of agriculture in the Alabama Polytechnic Institute, on March 6, 1910; Prof. C. F. Wheeler, formerly assistant botanist of the Michigan Agricultural College and Experiment Station, on March 5, 1910; Prof. S. B. Green, for many years at the head of the horticultural and forestry work of the Minnesota University and station, on July 11, 1910; and Dr. W. M. Munson, horticulturist of the West Virginia University and station, on September 9, 1910.

DR. CHARLES A. GOESSMANN.

Dr. Charles A. Goessmann, of Massachusetts, who died September 1, 1910, in his eighty-fourth year, had long been one of the most conspicuous figures in agricultural chemistry in this country. For nearly 40 years he had been an active member of the faculty of the Massachusetts Agricultural College, his service covering almost the entire period since the college was established. One of the earliest pioneers in agricultural investigation, his work had been not only a contribution to knowledge but an inspiration to others and a potent influence for the development of agricultural experimentation. It exhibited unusual activity and breadth of knowledge, and was characterized by a thoroughness and conservatism which gave great reliability to his conclusions.

Almost immediately after going to the college Dr. Goessmann took hold of the agricultural problems of the State, both practical and scientific, and made them the subject of investigation. He was a pioneer in every sense of the word, and he brought to his studies a broad training in science, full confidence in its ability to reveal the laws upon which agriculture depends, and the true scientific spirit, which seeks only the truth.

In 1873 he was appointed chemist to the State board of agriculture, and then began a series of reports and lectures which continued almost to the time of his retirement. In the early seventies he made extensive investigations of the beet as a source of sugar, and demonstrated the feasibility of growing beets for sugar in certain sections of the State and the practicability of developing it into a profitable industry. His work upon the sugar beet was epoch making, and furnished a starting point for the more recent studies and propa-

ganda in that line. He also made an important study of sorghum growing and the value of that crop for sugar. His conclusion that the presence of a large amount of grape sugar in the juice rendered the separation of the cane sugar impracticable on a commercial scale was verified much later by extensive commercial experiments.

His investigation of the salt marshes of the State and plans for their reclamation were embodied in a number of valuable papers. He also made extensive studies of the chemistry of the corn plant, the preservation of corn in the silo, the chemistry of fruits and the relation of fertilizers to their culture, etc. His study of the fertilizer industry, at that time in a most unsatisfactory condition, led to securing the first State law for the inspection of fertilizers, which became operative October 1, 1873. As State inspector he made his first report under the new law that year, and he was in charge of this inspection from that date to the time of his retirement in 1907.

Dr. Goessmann early began the advocacy of an experiment station at the college, illustrating by his studies the practical value of such an institution to the agriculture of the State. A station was started in 1878 with private contributions, and while studies were continued with the proceeds of the fertilizer inspection, it was not until 1882 that the State made definite provision for a station. He was then appointed director and remained at its head until it was merged with the Hatch station of the college in 1895. Under his direction the station became an efficient aid to the farmers and to the agriculture of the State, and was from the first one of the leading institutions of its kind in the country. Feeding experiments with dairy cattle and pigs, and fertilizer experiments with a wide range of field and garden crops were continued through long periods. In the latter he made noteworthy studies of the action and value of different forms of potash, phosphoric acid, and nitrogen, and their special effect on crops.

Dr. Goessmann was modest and without ostentation in all that he did, and was content to let his work justify itself by its merits. He sought no other reward; and his devotion to his study prevented his turning aside into commercial channels, which would have yielded greater pecuniary return.

The product of his activity is not measured in monetary terms, for the value of a movement which looks to the development of an industry on a more intelligent and secure basis is beyond such measure. It is found rather in a changed popular attitude which appropriates thousands for experimentation where hundreds were hesitatingly given before, in an unconscious change of practice, the real origin of which is rarely known, and in the lives and activities of a band of students who received from him their first encourage-

ment and inspiration, their standards and conception of values, and an outlook which has in large measure furnished the basis of their success.

PROF. WILLIAM H. BREWER.

Prof. William Henry Brewer, for 40 years professor of agriculture at the Sheffield Scientific School and long associated with the Connecticut Experiment Station, died November 2, 1910.

Prof. Brewer was a pioneer in agricultural instruction, having been connected with the early attempts to establish agricultural teaching at the Oakwood Agricultural Institute and at Ovid College, in New York State, in the early fifties. He became professor of agriculture in the Sheffield Scientific School in 1864, and occupied the position until 1904, when he retired as professor emeritus.

Dr. E. H. Jenkins, director of the Connecticut Experiment Station, has said of him:

His sympathy with farm interests was always active. He was a professor of agriculture not only in the Sheffield Scientific School but throughout the State. His addresses at farm meetings through many years, which were published in the reports of the State board of agriculture, did much to make its early reports sought after everywhere as an encyclopedia of farming.

He labored with his associate and friend, Dr. S. W. Johnson, for the establishment of an agricultural experiment station in Connecticut, the first station to be organized in the United States. He was a member of the board of control of the station from 1877 until his death, and served for many years as secretary and treasurer.

He was an ardent advocate of the care of the forests of the country, and was a member of a commission appointed from the National Academy of Sciences to prepare a plan for their preservation and increase.

A scholarly man, with an unusual breadth of information and interest in scientific matters, he represented agriculture, his teaching subject, in its true scientific relations as well as in its practical aspects. He thus exemplified the trained scientist in agricultural teaching, a conception by no means universal in his day. The high standing which he long maintained among men of science carried with it a recognition of the subject which he taught, and helped to a better understanding of its importance.

He was 82 years of age at the time of his death, having been born September 14, 1828.

NEW LINES OF WORK.

At the Kansas college and station a department for the investigation of problems dealing with the handling and milling of grain was established. An experimental baking plant is to be operated

which will have the twofold purpose of testing the bread-making capacity of flours from different kinds of wheat and of conducting experiments in the technology of baking. Later it is hoped to erect an experimental mill for use in conducting studies on milling qualities of wheats and of milling operations. The new department will cooperate with the entomologist in studies of insects damaging stored wheat and flour in transit, with the botanist in the control of plant diseases which affect the quality of flour, and with the agronomist in the distribution of improved seed wheat. Much interest is being manifested in the new department, and the millers of the State are actively cooperating in the work.

At the Nebraska University and station, L. W. Chase, of the department of agricultural engineering in the college of agriculture, was added to the station council with the title of agricultural engineer, and is conducting investigations in farm drainage and sanitation and the use of cement for farm purposes.

In Ohio the assembly authorized the establishment of the department of dairy husbandry at the station and appropriated \$8,000 for its support. Among the lines of investigation which are contemplated are the production of dairy stock, including feeding and breeding, utilization of food, the effect of special foods, notably those deficient in phosphorus, the quality of the milk, the birth weight and the vigor of the offspring, and the pathology of the dairy with special reference to tuberculosis. The dairy herd, buildings and equipment, and a portion of the station pastures are to be transferred to the new department. It is expected that the pathological work will be organized as a separate department. Special work in the line of wool investigations under the direction of the department of animal husbandry was recently authorized at this station.

By an act of the last legislature of North Carolina the duties of the State Crop Pest Commission were transferred to the State board of agriculture. A seed-inspection law was passed, the enforcement of which is left to the State board. The board is further given the authority to sell any of its test farms and to invest the net proceeds in similar farms elsewhere.

In Washington a feeding-stuffs law was enacted by the last legislature, the enforcement of which is to rest with the director of the station. The expenses of the inspection are to be defrayed by the sale of stamps and labels. A seed-inspection law was enacted in Wisconsin, which placed the station in charge of the enforcement of the act.

In Arizona the station entomologist serves as entomologist of the newly established Territorial horticultural commission, which is charged with carrying out the provisions of a rigid crop pest law providing for inspection and quarantine.

A short course in horticulture was held at Davis, Cal., April 26 to May 20, at which a special feature was a preparatory course for prospective horticultural commissioners and inspectors under the new State law. The course was preceded by a three-day conference of Pacific slope entomologists at Berkeley, for the consideration of the special insect problems of the region. At this conference a permanent organization was effected under the name of Pacific Slope Association of Economic Entomologists. Active membership is restricted to official and professional entomologists of the Pacific slope. C. W. Woodworth was elected president and W. B. Herms secretary-treasurer of this new association.

The enforcement of the new stallion inspection law in North Dakota was placed in charge of the North Dakota college and station, and immediately under the head of the animal husbandry division. Stallion registration laws are now in operation in 15 States. The object of these laws is to exclude unsound or diseased animals from service, and guard against fraud in the case of animals claimed to be pure bred. An organization of officials charged with the administration of these laws, mainly college and station men, was formed in the summer of 1910, with a view to securing unification of the State laws.

At the second annual meeting of the Association of Feed Control Officials of the United States, which is composed largely of experiment station men, the importance of enacting and enforcing uniform and just laws relating to the manufacture and sale of feeding stuffs was discussed, and a draft for a uniform State feeding-stuffs law recommended by the executive committee was adopted. A list of definitions of terms used to describe by-products used as feeding stuffs for live stock was also discussed and adopted.

Under an act signed by President Taft April 26, 1910, the manufacture, sale, or transportation in interstate commerce, the District of Columbia, or the Territories, of adulterated or misbranded Paris green, lead arsenate, and other insecticides and fungicides is prohibited after January 1, 1911, at which time the act goes into effect.

An association of college and station workers interested in the subject of farm management was formed during the course of the graduate school at Ames, Iowa, and a society of milling and baking technology has also been organized.

INCREASE IN FUNDS AND EQUIPMENT.

The revenues of the stations for the year aggregated nearly \$3,000,000. Of this amount \$1,344,000 was received from the Federal Government and the balance was contributed by the States and from local sources. These local agencies are, therefore, more than doubling the funds of the stations from Federal sources.

A few cases remain in which the States make no specific appropriation for the station, but in such cases the restrictions surrounding the Federal funds make it very difficult for the stations to meet all the varied demands upon them.

Among the new appropriations for the year the following may be mentioned:

The Oregon college and station received among other appropriations \$20,000 for the purchase of additional land; \$2,500 was made available for dry-farm experiments, and \$3,000 for irrigation experiments, both in cooperation with this department; and \$15,000 was granted for the maintenance of the eastern Oregon substation.

In Wyoming \$7,500 was provided by the legislature for experimental work in dry farming. In Connecticut \$4,000 was given for maintenance of the Storrs station, and \$8,500 for the purchase of an additional farm.

The appropriations made by the General Assembly of Ohio to the station for the ensuing year aggregated \$166,295, an increase of nearly \$50,000 over the previous year. Some of the principal items were \$26,300 for administration, \$16,475 for agronomy, \$15,000 for animal husbandry, \$10,900 for botany, \$20,470 for cooperative experiments, \$5,000 for entomology, \$10,000 for forestry, \$10,500 for soils, \$3,700 for chemistry, \$10,950 for horticulture, \$4,000 for nutrition, \$17,000 for completing the nutrition building, \$3,000 for the extension of the power house, and \$4,000 for the purchase of land. In addition to this there was an appropriation of \$8,000 for the new department of dairy husbandry.

In Texas a State appropriation of \$1,000 annually for the current biennium was made for tobacco investigations, in cooperation with the Bureau of Plant Industry of this department at its tobacco station at Nacogdoches.

Under an act passed by Congress the State of Colorado may purchase 1,600 acres of public land in Larimer County for the use of the college and station. In this way it is hoped to obtain considerable tracts of land in reasonable proximity to the college, too broken and rocky as a whole for agriculture, but containing parcels of from 1 to 4 acres, at various altitudes, which can be used to advantage for experimental and demonstration purposes.

The Colorado Legislature also appropriated \$50,000 for work in agricultural extension, which will be largely spent in holding one-week extension schools throughout the State. During the year 34 such schools were held and it is hoped to double this number during the coming year.

The New York Legislature in making its appropriations for Cornell University included an increase of \$2,000 for extension work and \$90,000 for a poultry building.

The Kentucky Legislature appropriated \$2,000 for the preparation and distribution of hog-cholera serum by the station.

In Massachusetts an appropriation of \$15,000 was made for the purchase of a cranberry bog and for buildings and equipment. A bog was purchased at a cost of \$12,700, and a small building for use in handling the crop and to provide quarters for office and laboratory work is to be erected.

The research laboratory of the Connecticut State station was destroyed by fire on January 1, 1910, the most serious item of loss being the valuable chemical laboratory and the animals which had been under experiment for five months. The more valuable records were in a fireproof vault, which was uninjured. The legislature has made an appropriation of \$30,000 for a fireproof addition to the station laboratories to replace this building. According to the plans for the new structure, the basement contains a laboratory, rooms for machinery, sampling, storage, and spraying apparatus, and a fireproof vault; the first floor, a large chemical laboratory with offices, storerooms, and library, the forester's office and workroom, rooms for the botanical library and collections, the botanist's offices and laboratories, and a second fireproof vault; and the second floor, three chemical laboratories with an office, library, and storerooms, and rooms for the entomological collections, library, office, and laboratories. Outside of this building but connecting with it is to be a two-story addition of glass and concrete, including an insectary and greenhouse for the study of plant diseases. Among the new buildings to be erected at the Connecticut college and station is a poultry plant to cost about \$5,000.

A brick annex to the botanical building at the Michigan station, 33 by 61 feet, with two stories and basement, costing about \$13,000, together with a greenhouse, 24 by 40 feet, was erected. The erection of a tool shed and workroom and a laboratory building for spraying materials was authorized at the Virginia truck station. A horse barn, costing \$5,000, was erected on the Wyoming University stock farm.

Considerable progress was made at the Guam station in clearing station land, laying out roads, and building fences. During the year nearly the entire station area has been brought under cultivation, and a small plantation of coffee comprising approximately 1 acre of hill land was established for the purpose of demonstrating the practicability of cultivating the relatively large areas of land of this class which are now unused.

Funds were allotted from the Hawaii Territorial income tax to erect a new office building for the station at Honolulu. This new structure is to be provided with rooms for the library, storage space for bulletins, and offices for five or six members of the staff. The

old office building is to be turned over to the joint use of the chemist and bacteriologist, and the quarters now used by the chemist will be used for storage purposes.

At the University of Missouri the new agricultural hall was dedicated during the sixth annual farmers' week, on December 28. The Rhode Island station completed a hospital building for use in the investigation of the diseases of poultry and methods for their control.

At the North Dakota college and station an excellent new veterinary building was completed and provided with equipment. A new chemistry building is being built to replace the one destroyed by fire last year, a seed house at the Dickinson substation to cost \$3,500, and a residence at the Hettinger substation. The station sheep barns have also been enlarged.

At the South Dakota station a very complete fruit-breeding house was erected, to be used entirely in the work of originating hardy fruits for western conditions. This is reported to be the largest structure for conducting breeding studies to be found in the world.

The Ohio station has let contracts for the erection of a soil laboratory 23 by 30 feet in size, one and one-half stories high, and also for a one and one-half story brick power house, 34 by 39 feet. A dwelling near the main building was purchased for office purposes until funds can be secured for additional office and laboratory structures.

At the Florida station \$7,500 was allotted for the equipment of the new station building.

At the Nevada station, one wing of a new greenhouse was erected at a cost of \$5,000, and a room for the station library added to one of the buildings and equipped.

The new buildings erected during the year at the Colorado station include a number of structures costing about \$2,000, for use in the station poultry experiments, and a model potato cellar costing about \$800. About one-third of the space in the new irrigation engineering building, which was completed during the year, is provided for the experiment station.

A new building for the departments of entomology and geology at the Massachusetts college and station was completed and dedicated soon after the close of the fiscal year. The appropriation for this building was \$80,000, to which has been added \$15,000 for equipment.

The Minnesota station erected and equipped during the year a new vaccine building, at an approximate cost of \$10,000. This building was equipped especially for the manufacture of virus. The denatured-alcohol plant provided for last year was erected and equipped for experimental work on the production of alcohol and will be ready for operation in 1911. The capacity of the plant is 50 proof gallons of alcohol per day, and its cost was \$6,000. Further, a

thoroughly modern baking and testing laboratory was installed and equipped with electric baking and drying ovens, sponge cases, experimental flour mill, and other necessary equipment for investigations in connection with wheat and flour chemistry and technology.

A new dairy building was completed at the New Hampshire station, and the dairy stables were remodeled at an expense of about \$3,000.

At the Puyallup (Wash.) substation a new building with a small greenhouse attached was erected, at a cost of about \$4,500, appropriated by the State.

INVESTIGATIONS UNDER THE ADAMS ACT.

During the year work on 335 projects under this fund was conducted at 50 stations. The same high standards are being insisted upon as formerly, and the requirements of the act are becoming more generally understood, so that the supervision of the fund gives less difficulty. There is still a tendency, however, to place on this fund too large a number of projects, and in several cases to include matters which are rather trivial as subjects for an investigation fund.

In some cases the projects proposed continue to be of much too broad and indefinite a character. They embrace the whole field of research rather than any specific and definite phases of the subject; they aim, not at the scientific solution of a project in agriculture, but rather at the attempt to secure some practical method or result of immediate application without regard to a thorough understanding of the scientific basis for the method or the generalizations.

A recent example of a blanket proposal for studies covering a wide range of subjects is a suggested project on indigenous species of insects attacking agricultural crops. This proposition lacks both the definiteness and the restriction in scope which should characterize a subject for investigation; and as far as any control of the work is concerned, it could be interpreted to cover the whole field of economic entomology as applied to the particular locality. Obviously only occasional observations could be made, for it would be wholly impracticable with the facilities at the command of any single experiment station to investigate this subject as a whole in any systematic or thorough manner.

A desire is frequently encountered among certain station workers to outline so broad and general a project that they will be free from limitations and can follow their inclination from year to year as to the particular course of their investigations. But in the light of experience it is evident that from the standpoint of the investigation itself, as well as of the administration of the work, men should be held to carefully considered subjects of reasonable scope, definite scientific character, and directed along original lines.

There is still a tendency at some stations to be satisfied with inconclusive and incomplete work. Projects are selected and outlined with considerable definiteness, and then after a year or two's work interest in them appears to be lost or difficulties are encountered which there is a lack of inclination to work out, and it is then proposed to abandon the projects. It must be evident that such work is unproductive and unprofitable, and illustrates a tendency which should be dealt with by administrative officers. Not all men who are useful station workers are fitted to conduct research work. It should be evident before a man is encouraged to outline a project that he has some research ability which warrants assigning such activities to him. It should be further evident that the investigation he outlines is a practical project in the present stage of knowledge, and is one which he is competent to attack. There must necessarily be many failures to work out in complete and final form the projects which are entered upon, but a disposition to work only on the fringe of a subject and to abandon a project when real difficulties begin to be encountered or when some other matter attracts the interest, will defeat the purpose of serious investigation and should be discountenanced by administrative officers.

Taken as a whole, however, the Adams-fund projects present a strong list of agricultural investigations, outlined in a thorough manner, with a disposition to derive fundamental facts. The spirit of the men working under this research fund has improved from year to year, and their attitude toward it has become in a large percentage of the cases that of the true seeker after truth. Already many important results are coming out of these investigations, some of which are ready for publication and others merely marking the passage of a certain important stage. Nothing could be more helpful than a suitable organ for the publication of these investigations, which would stimulate to higher effort and more clearly illustrate the character of agricultural research, as well as give publicity to the findings.

STATION ADMINISTRATION.

The question of adequate provision for the administration of the experiment station is a highly important one. Administrative duties are at present quite complex. They involve the intimate supervision of the internal affairs of the station—the work of the individual men, the facilities for promoting their efficiency, their relations as a body, the publications of the station, and its financial management; its relations to the institution of which it is a part, to this office, through which general supervision of the Federal funds is exercised, to the people of the State, and in a broader sense to agri-

culture as a science and an art. The station should present a strong effective front, and should be developed and conducted on the basis of carefully matured plans. With competent heads of departments and a clear policy relating to the work and expenditures, a high degree of efficiency can be maintained in individual departments. But in many respects the station should exist as a unit, and not merely as an aggregation of several independent departments. Without plans and direction, the formulation of definite policy, and provision for meeting the needs and requirements of the institution as a whole, the conduct of the station will be haphazard and unbusinesslike, and aside from a lack of the highest efficiency embarrassing difficulties will be encountered with the finances and otherwise. All but two of the stations (Nevada and North Dakota) are now presided over by separate directors; in these two exceptions the president of the university or college holds the position of director. In a considerable number of other cases the position of dean of the college of agriculture and director of the experiment station is combined in a single officer, who frequently has other duties assigned to him, such as charge of the domestic science department, general supervision of the extension work, etc.

The growth of the stations and the complication of their activity makes the need of effective direction increasingly imperative. That this need is not always being fully met is evidenced by the inspection conducted by this office and by its various dealings with the stations. This is a fault of the present system rather than of the men working under it. These men are usually overburdened with responsibilities. They are trying to cover too broad a field and to administer too many different classes of undertakings, and the organization is not such as to relieve them sufficiently of responsibility for details. As a result many important matters fail to receive the attention or consideration which good administration demands, and the actual touch with the work is often not close.

At many institutions the instruction work in agriculture, the new extension features, and the inspection, demonstration, and investigation work of the experiment stations have developed so rapidly and to such magnitude that the combination dean and director can, in the nature of the case, give but little attention to any of them in detail. The administrative work has outgrown the ability of a single man to handle it, except in a most general and supervisory manner; and to meet this no adequate provision has been made for an associate or executive officer to represent the dean in looking after the details of administration.

In the early history of the stations it was not uncommon for the president of the college to act as director of the experiment station.

This plan was found generally unsatisfactory, for the reason that the president had many other duties and interests, and was frequently not particularly adapted by training or experience to the direction of an experiment station. The history of the stations has shown that plan to be ineffective, and it has been almost entirely superseded by the appointment of separate administrative officers for the stations.

The combined duties of the deanship and the directorship have reached a point in some of the larger institutions where the condition is quite analogous to that prevailing when the directorship was in the hands of the president of the college. While the combined dean and director usually has special fitness for administering the station work as a result of training and experience, the extent of the enterprises assigned to that dual officer at a number of the institutions is at present considerably greater than was the administration of most agricultural colleges 10 or 15 years ago. The station's appropriation is frequently larger and its working force greater in number than was the case with the agricultural colleges at that time, and the manifold activities and relations of the station make heavy calls on the time of the administrative officer. The coming of the Adams fund, with its special provision for research as distinguished from other grades of activity, and the increased State appropriations for the development of special lines of experimentation, branch stations, etc., has complicated the station management and made intelligent supervision essential to the highest effectiveness. Granting the largest measure of academic freedom in experiment station work, the activities of the different departments are promoted by a general following up of their progress and their relations to other lines of duty. The matter of providing suitable permanent records of the work calls for attention and should receive more than it often does; and the preparation of various reports calls for rather intimate knowledge in regard to the progress in various lines. These and many other things are in the function of the station director. Taken as a whole, the proper administration of an experiment station is in itself a large undertaking.

While the advantages of combining the collegiate, the experiment station, and the extension work in agriculture under a single administrative head may be recognized by the office of dean, it seems clear that the time has come in the larger institutions when provision should be made in the organization for an officer who will directly perform the functions of station director and represent the dean in the carrying out of details and the execution of general policy. Such an executive officer would enable the dean to give his personal attention to the larger matters pertaining to the institution as a whole, and the correlation and development of its work.

PUBLICATIONS OF THE STATIONS.

The publicity work of the experiment stations increases from year to year. The growth of extension work has led to a large number of popular bulletins and circulars which have been issued in the experiment station series, although paid for out of special funds. In accordance with the ruling that the Federal funds should be relieved from all kinds of expenses incidental to extension work, special attention has been given to the character of the publications assigned to the Federal funds.

In the majority of cases care has been exercised by the stations to charge to the Hatch fund only such publications as clearly report the results of their work. In some cases insufficient attention has been given to this matter, with the result that publications clearly of elementary and extension character were charged against the Hatch fund, when there were State funds to which they might have been assigned. Such a practice has necessitated a disallowance of the expenditure for the particular publications involved. In other cases the States have not yet made adequate provision for extension work or for publications of that character, and many popular bulletins have been printed from the Federal funds. This has led to no question when the bulletin was based on the station's work, and was in effect a popular presentation of the results of such work, with such explanatory matter as the necessities of the case seemed to make reasonable; but the subject matter has not always been so worded as to bring out the station's connection with the discussion, and this has led to much correspondence with the stations relative to their popular publications, and in some cases to a final refusal to allow the charge for the publication.

It is maintained that at the present stage the station bulletins should present the experimental evidence on which their conclusions and directions are based in such manner as to show clearly the station's contribution to the subject. The reader is entitled to this and the station is entitled to credit for its work. Such a form of presentation detracts in no way from the interest or value of a bulletin, popular or technical. Unless this is done it is impossible even for the well-informed reader to distinguish between what is new and what are merely generalizations from experience and the common fund of information.

The stations have been strongly urged, therefore, to restrict their charges against the Federal funds to such publications as report the results and applications of their work, and in the popular accounts of station work to clearly credit the station with the work which it has done,

SOME NOTEWORTHY RESULTS OF STATION WORK.

The increase in the fund of knowledge and its application as a result of the stations' work grows rapidly from year to year. New facts are brought out which help the investigator to a clearer understanding of his problems and bring him nearer to a solution; and a vast amount of experimental evidence is accumulated to assist practical men in improving their methods and overcoming natural difficulties.

No other business or profession has such an organized and aggressive system working for its advancement in both theory and practice. The outcome in every branch of agriculture is enormous, and it is only possible to cite a few of the results to indicate the nature and scope of the progress.

The development of new varieties and their distribution among the farmers of the States continued during the year with much success. A new variety of winter wheat developed at the Minnesota station, known as Minnesota No. 529, and three varieties of oats, Minnesota Nos. 261, 281, and 295, which outyielded the ordinary grains by 15 to 25 per cent, were distributed. Minnesota No. 169 wheat, No. 26 oats, No. 13 corn, and No. 25 flax have become commercially known and are now quite widely grown in Minnesota and the adjoining States. It is estimated that the increased value of farm crops in Minnesota, on account of the use of varieties of grain developed at the station, has reached the sum of \$6,500,000 annually.

The pedigreed strains of corn developed by the Ohio station are thus far yielding 5 to 14 bushels per acre more than the original varieties from which they were selected and bred. Pedigreed strains of oats and wheat are yielding 3 to 6 bushels in advance of the original stock, and improved strains of soy beans $2\frac{1}{2}$ to 6 bushels.

The North Dakota station has also achieved success in establishing new varieties of field crops and distributing them throughout the State. In corn-breeding work, the ear-to-row corn yields have been very outstanding, ranging from 96 bushels per acre to 37.7 bushels for the different ear rows. Golden Dent No. 950 seed corn has been widely distributed through sales direct from the institution, through the demonstration farms, and the school children's contests. It has proved very popular through the State and has added greatly to the corn area.

No. 316 blue-stem wheat was put out through the medium of the demonstration farms the past year. It is the result of 17 years' work. The yield of this new wheat during the very dry season of 1910 was $27\frac{1}{2}$ bushels per acre on a field plat of over 5 acres in size. The winter rye developed by the station is proving hardy and a better yielder than the common varieties.

In one county of the State of Missouri corn yields have been increased $16\frac{1}{2}$ bushels per acre and clover yields $1\frac{3}{4}$ tons per acre by the application of results discovered by the station. Good soil management on one of the experiment fields increased the clover yield from one-half ton to 2 tons per acre and the net profit by \$6. On the soil-experiment fields in southwestern Missouri the station has shown that corn may be increased from 20 to 45 bushels per acre and wheat 12 bushels per acre. In soil experiments carried on in northeastern Missouri the yield of wheat was increased by 50 bushels per acre, with a corresponding increase in the net profit.

The results of the timothy-breeding experiments at the New York Cornell station are becoming apparent. Some very marked hay and pasture strains have been developed.

What is probably the largest fruit-breeding station in the world is well under way in Minnesota. The object is to secure hardiness and resistance to several prevalent diseases, and the extensive and systematic scheme which is followed promises valuable results. The very large amount of material now growing furnishes opportunity for extensive breeding studies.

The fruit-breeding work of the South Dakota station has resulted in obtaining hybrid varieties from the Japan and De Soto plums and the native sand cherry. Three promising crosses have also been secured by the union of the native plum and the Chinese apricot. Two new hybrids, of which the sand cherry is the female parent and the De Soto plum the male parent, were sent out in the spring of 1910.

A monograph of the plums of North America has been completed by the New York State station, based on its extensive and long-continued studies of varieties. This work is on a scale comparable with the excellent monographs on apples and grapes, previously issued.

At the Arizona station it has been found that date ripening may be hastened by spraying the immature fruit with a solution of acetic acid, thus causing choice varieties to ripen in that region. In a study of tuberization at the same station, greening the tubers prior to planting resulted in the formation of a larger and better crop. Checking the growth of tops by any means had a similar effect.

The experiments on the effect of high pressures on preserving fruits and fruit juices, which have been in progress at the West Virginia station for a number of years, have been completed, and it has been found that high pressures, continuous or intermittent, and at natural temperature or in connection with heat, destroy the organisms responsible for the spoiling of canned fruits, etc.

Attempts to breed poultry for high egg production have resulted in many disappointments. The cause of this, as the Maine station has shown, lies not in the fact that high production is not trans-

mitted, but rather in the wide differences in ability of individuals to transmit that quality. This ability is found to be a family trait, some families of high production having it and others not. High egg production is shown to be inherited in pure lines, within families having the ability to transmit it. This faculty is the keynote to breeding, and has furnished a new method of selection for high performance, which is working out satisfactorily.

The same has been discovered to be true with corn. Superiority in respect to a quality is not necessarily accompanied by ability to transmit that quality; this is a family trait and, like the high quality itself, is transmitted within family lines—a very significant fact to be reckoned with in all breeding for improvement.

The important question as to whether such crops as corn, oats, etc., profit by the ability of legumes to assimilate the free nitrogen of the air, when grown in connection with them, has at length been answered in the affirmative by the New Jersey station, in an ingenious series of investigations. The manner in which the interchange of material takes place is a subject for further study.

At the Cornell station it was found that the growth of a legume with a nonlegume gave the latter a greater protein content than when it was grown alone. The growth of alfalfa was found to increase the nitrifying power of the soil. Both legumes and non-legumes were shown to have a definite relation to the nitrogen content of the soil on which they were grown, the relation differing with different crops. The absorption of nitrate nitrogen by wheat plants grown in a rich soil was found not to be proportional to the growth of the plants but to increase with a decrease in the soil moisture content and consequently with a decrease in the crop. This result is considered as a probable explanation of the high percentage of gluten in wheat grown in semiarid regions. In studying the relation of lime to the growth of alfalfa it was observed that the protein content of alfalfa grown on lime soil was markedly greater than that grown on soil in need of lime. In these experiments the difference amounted to 88 pounds of protein per ten of alfalfa hay.

The significance of sulphur as a plant food, not heretofore taken account of, is indicated by studies made at the Wisconsin station with a new method of analysis. By this, grain crops, for example, are found to remove nearly as much sulphur from the soil as they do of phosphoric acid, whereas the soil supply of sulphur is far less.

This fact must evidently be taken account of in plans for maintaining fertility.

A new disease of cucumbers and muskmelons in the greenhouse was worked out at the New York State station, and its cause determined. The fungus has since appeared upon tomatoes both in this country and in Europe. In cooperation with the Vermont station

the pathogenicity of the organisms causing the soft rots of a number of fruits and vegetables has been thoroughly worked out.

The cause of a new disease of alfalfa has been worked out at the Colorado station, which was found to be due to bacteria. Only the first crop is seriously affected, and this was found to be due to late frosts causing a cracking of the stems, the bacteria finding entrance through the injury.

The Maine station reports the presence of the blackleg of potatoes in several portions of the United States. The disease is of bacterial origin, and in Germany, where it was first noticed, it has proved very troublesome at times.

The Ohio station has reported a number of important new diseases of plants, among them a bacterial disease of cereals and grasses, in which there seems to be a communism between two distinct organisms. The same station has demonstrated the efficiency of spraying with solutions of common salt for the destruction of poison ivy and other weeds.

A new standard for feeding dairy cows has been worked out by Prof. Haecker in Minnesota, which is more practical and economical for American conditions than the German standards. In this study large numbers of animals have been used, under natural conditions, and an immense mass of scientific data has been accumulated.

The Pennsylvania station, following up the results of experiments in the respiration calorimeter, carried on in cooperation with the Bureau of Animal Industry of this department, found that steers made as good gains when fed in a dry, open lot sheltered on the north and west sides as did a similar number of animals fed in a warm, well-ventilated stable.

The Oklahoma station determined the fact that Kafir corn ranks close to corn as a feed for cattle and hogs, and also as a raw material for the manufacture of alcohol and glucose.

A preliminary report of experiments at the Ohio station showed marked differences in the availability of organic and inorganic forms of phosphorus when fed to pigs.

The method of making cheese from pasteurized milk with the use of commercial acid for ripening the milk has been perfected at the Wisconsin station. This eliminates the difficulty due to defects in the milk, and reduces cheese making largely to a mechanical process which can be controlled at the various stages and carried out by definite rule. The cheese made in this way is mild in flavor, does not require to be ripened at a low temperature, and keeps well on the market.

The West Virginia station has constructed a device enabling the handling of milk in the cooling process in such a way that con-

tamination through contact with the air in an open room is prevented. The station has shown by experiments that the bacterial content of the milk is very greatly increased by the usual methods of artificial cooling in an open room, and its device avoids this.

In connection with the investigations of the bacillary white diarrhea in chickens, the Connecticut Storrs station in cooperation with Yale University claims to have isolated the organism which causes the disease, and thus definitely determined the cause of this trouble. Suggestions are made for its avoidance.

Much success has been secured in the use of serum against hog cholera, and in several States the stations are preparing the serum under State appropriation. The Minnesota station reported no failures when full doses of tested serum were given in herds not already affected, and when herds already infected were treated the results were as satisfactory as could be reasonably expected. Up to March 1, 1910, 1,604 individuals in infected herds were vaccinated, of which 69 died, while 70 out of 76 not vaccinated died. In sound herds 982 were vaccinated with a full dose of tested serum, of which 12 died. All vaccinated hogs were tested by inoculation or exposure. During the year data were also secured indicating that pigs from immune sows are born with very high resistance to cholera. This natural immunity is gradually lost, but is sufficient up to five weeks of age to permit such pigs to be inoculated with very high virulent blood with an unimportant percentage of loss.

The Indiana station reports the discovery that normal salt solution which has been injected into the abdominal cavity of a hog affected with cholera can be substituted for virulent blood in the preparation of hyperimmune hogs. This has cheapened the treatment fully one-third, and is held to be the most important discovery since the present method of treating hog cholera was introduced. In these experiments a normal salt solution was injected into the abdominal cavities of a number of hogs used in the work. Two hours later these hogs were bled and as soon as the animals had died the virulent salt solution was removed. Eleven hyperimmunes were produced with this normal salt solution and all of them yielded potent serum.

The deterioration of cement under the action of alkali has been studied at the Montana station. The action of alkali salts destroys the binding material of the cement (calcium hydrate), and also increases the volume of the mass, making it bulge and crack and crumble. This is a matter of great importance in the alkali regions in connection with the construction of irrigation works and farm buildings, as well as other structures. Means for preventing the deterioration have been proposed.

PROGRESS IN FOREIGN COUNTRIES.

Efforts are being put forth to provide national encouragement of British agriculture and forestry, with an increase of the national grant to agriculture by \$1,000,000 with a view to more extensive development of the resources of the country. Such projects as the institution of schools of forestry, the purchase and preparation of land for afforestation, the maintenance of experimental forests, increased aid to scientific research in agriculture, experimental farms, the encouragement of agricultural cooperation and better transportation facilities, systematic extension work, and the aiding in a general way of a movement back to the farm are contemplated. An extensive afforestation project has been receiving considerable discussion. It is estimated that 9,000,000 acres are available for the purpose, and an annual afforestation of 10,000 acres would afford employment to 18,000 men temporarily and 1,500 permanently and would eventually yield a large revenue.

The new agricultural buildings for Cambridge University were made ready for occupancy during the year. The cost, with equipment, is estimated at about \$87,500.

The agricultural and road development act passed by the British Parliament provides for aiding and developing agriculture and rural industries by promoting scientific research, instruction, and experiments in the science, methods, and practice of agriculture. The president of the board of agriculture and fisheries has appointed a committee of 15 to advise the board on all scientific questions bearing directly on the importance of agriculture, and especially as to methods to be adopted for promoting agricultural research in universities and other scientific schools, aiding scientific research workers, and insuring that new scientific discoveries are utilized for the benefit of agriculture.

A society was organized under the presidency of the Duke of Devonshire for the purpose of raising \$25,000 for the purchase of about 200 acres of land adjoining the present experimental fields at Rothamsted, and erecting buildings for feeding experiments with crops to be grown there.

The appropriations for Canadian agriculture authorized for the ensuing year include items of \$185,000 for the maintenance of experimental farms, including an increase of \$45,000 for the establishment of additional farms, \$10,000 for the publications of the experimental farms, \$5,000 for five stations for the fumigation of nursery stock, \$100,000 for the development of the dairy and fruit industries, \$82,000 for the establishment of cold-storage warehouses and the experiments in cold storage for fruit, \$52,000 for the development of the meat

industry, \$250,000 for animal diseases, \$50,000 for the seed-inspection work, \$20,000 for the enforcement of the meat and canned foods acts, \$5,000 for tobacco investigations, and \$10,000 for the International Institute of Agriculture. J. H. Grisdale, of the Experimental Farm, was appointed Dominion agriculturist, with supervision of operations at all branch stations and at the Central Farm in both animal husbandry and field crops. An experimental farm under the general supervision of the Central Experimental Farm at Ottawa is being established on Prince Edward Island, a tract of 65 acres having been selected close to Charlottetown on which experiments will be conducted on cereals, fruits, vegetables, trees, shrubs, etc. J. A. Clark was appointed superintendent. The Canadian Pacific Railway established a demonstration farm at Strathmore, Canada.

Considerable activity was shown in the establishment of experiment farms in Australia. In New South Wales the Nyngan Experimental Farm was opened, together with a viticultural station near Raymond Terrace, where work was begun on the growing of phylloxera-resistant stocks. Experimental work was also inaugurated in various parts of Kangaroo Island. An experiment farm of 600 acres was established at Loxton, in South Australia, where work along dry-farming lines is to be taken up. Steps were also taken toward the establishment of a poultry experiment farm in South Australia, and between Petersburg and Yunta experimental dry-farming work was commenced on a 3,000-acre tract, attention being first given to fallowing operations. An experiment farm was also established at Shannon, on Eyre Peninsula.

The botanical department of agriculture in India has laid out a farm and erected a building with a view to studying the decline of the Tasar silk industry, and for the purpose of fostering the same. Four stations, including one sericultural station, were established in Indo China.

In Germany the Dairy Experiment Station and Institute at Kleinhof-Tapiau was removed on April 1, 1910, to Königsberg, where it is housed in recently erected buildings of the Königsberg Cooperative Dairy Association. The Agricultural Experiment Station of the Chamber of Agriculture of the District of Cassel was removed in June from Marburg to Harleshausen, near Cassel. An institute for animal physiology was established near Greifswald, on the small Baltic Island of Riems, under the direction of Prof. N. Zuntz, of Berlin. One of the principal lines of work to be taken up by this institution is bacteriological investigations for the control of foot-and-mouth disease. This institute will be under the control of the University of Greifswald.

Steps were taken during the year for the organization of an association of agricultural experiment stations in Austria, and at a pre-

liminary meeting of representatives of the stations of that country it was decided to form such an organization, and a committee on organization was appointed. An organ of the association has been selected.

In France an experiment station for refrigeration was established at Chateaurenard, the center of a large fruit-growing district, where experiments are to be made with respect to the transportation of perishable produce.

The Gembloux station in Belgium was reorganized and is now composed of a state chemical institute, and the experimental and informational services connected with the state agricultural institute, which gives special attention to dairying, phytopathology, and entomology. The administration of the station is to be by council composed of the directors and chiefs of the different sections.

The Khedivial Agricultural Society of Egypt has acquired an experiment farm of about 160 acres near Cairo, and effected an arrangement with the state domains administration whereby a considerable tract of land is set aside for the raising of cotton and wheat seed of good quality. A committee was appointed to investigate the diminished yield of cotton in proportion to the area sown.

A cottonseed farm was established in British East Africa during the year.

In Portuguese East Africa, an experimental farm was established at Huambo and one at Libollo in the Province of Angola.

The agricultural station established at Tuyen-Ouang, China, has given special attention to the culture of manila hemp, and has also become a center for silk culture. This station was established under contract with the Government to continue during the three years 1908-1910.

In Spain, the establishment of an experiment station has been ordered by the Government at Fonsagrada, in the Province of Lugo, and an enological station was recently established at Jumulla in the Province of Murcia. A model experiment farm for the purpose of studying irrigation methods was opened at Seville, and a station for vegetable pathology at Burjasot, near Valencia, as a part of the school of practical agriculture located at that place.

The Venezuelan Government has ordered the establishment of a section of plants and seeds under the agricultural division of the ministry of commerce. This section is charged with the importation of seeds and plants approved by the minister. The seeds and plants are propagated and distributed to farmers with full cultural instructions, and a report is demanded from the parties taking advantage of this arrangement. A tobacco experiment station was recently established in Honduras.

In Peru a cotton experiment station was provided with which later was associated a sericultural station.

A bureau of agricultural inspection was organized in Brazil with the special duty of studying agricultural conditions and suggesting opportunities for improvement. Among other duties this bureau is charged with the introduction of new crops or the extension of those already under culture and the inspection of experiment stations. The country will be divided into 12 districts with an inspector in charge of each. An expenditure of \$3,000 was authorized for the introduction of dry-farming methods. The establishment of experiment stations for the cultivation and extraction of rubber was also authorized. Subsidies were authorized for wheat growing, production of beans, exportation of wine, rubber culture, sheep raising, and wool production. The Brazilian National Museum was reorganized, and provision was made for the study of fiber plants, insects harmful and beneficial to agriculture, plant diseases, and other lines of work of agricultural importance. The State of Para established propagation and acclimatization gardens, and the botanical gardens of Rio de Janeiro were ordered by Government decree to take up experimental work as outlined by the minister of agriculture. A department is to be maintained for the study of trees and other plants grown for commercial purposes and especially of native fruits. The commission to demonstrate rice culture was discontinued, and succeeded by a commission to experiment with wheat and its culture at Moreira Cesar in Rio Grande do Sul. A zootechnical station was established at Porto Alegre in the same State, the work to be carried on cooperatively with the central association for the promotion of scientific interests in the State. In São Paulo a poultry experiment station was located at Pindamonhangaba.

The Cuban agricultural budget for 1910 included an item of \$100,000 for cattle breeding, one of \$30,000 for subsidies to experimental farms, and one of \$20,000 for the purchase of plants and seeds.

An agricultural lecturer was sent by the Mexican Government to stimulate interest in better farming in the State of Sonora. The Government also provided a bureau charged among other things with matters pertaining to agricultural experiments and the dissemination of agricultural information. A new station was established near Oaxaca. The buildings are to cost about \$225,000 in Mexican money. Separate orchards of peaches, olives, oranges, and other fruits have been set out, and a pipe line 1,000 meters long has been constructed for irrigation purposes. A sugar mill has been set up and is ready for experimental work. This is the third station established in the country, the first having been established in San Luis Potosi in 1906. The station is located 4 miles from Oaxaca and has 2,000 acres of

bottom and hill land at its disposal. Although the third station to receive the Government grant, it was about the first to begin actual experimental operations.

INSPECTION OF THE STATIONS.

In accordance with the usual practice of the office, a personal inspection was made during the year of the work and expenditures of every experiment station receiving Federal funds. In connection with this inspection a large amount of first-hand information was secured in regard to the progress of these institutions, and the opportunity was embraced for conference with the local station officers in regard to the work and administration. This inspection was participated in by four members of the office force, namely: The Director (A. C. True), Assistant Director (E. W. Allen), W. H. Beal, and Walter H. Evans.

The following reports upon the several stations are based on the results of this inspection, together with the annual financial statements of the stations rendered on the schedules prescribed by the Secretary of Agriculture, and the printed and other reports received from the station officers.

ALABAMA.

Agricultural Experiment Station of the Alabama Polytechnic Institute,
Auburn.

Department of the Alabama Polytechnic Institute.

J. F. DUGGAR, M. S., *Director.*

The year's work at the Alabama station was carried on without many changes in the station staff and without any marked departures from the lines and methods of investigation followed last year. J. C. C. Price was appointed assistant in horticulture and J. E. Toomer assistant in chemistry. During the year the new agricultural building, costing about \$75,000, was occupied jointly by the college and the station, and a new greenhouse was constructed at a cost of about \$1,500. The station had an interest in the State horticultural fund amounting to \$1,500, which was used for nursery inspection in charge of the horticulturist. The department of animal husbandry received \$2,700 from State funds. The Live-Stock Sanitary Board has an annual appropriation of \$4,000 for tick eradication, and the station veterinarian is connected with this work.

Progress is reported in the work on the various Adams-fund projects which the station has under investigation. In agronomy the plant-breeding work with cotton, corn, and oats was continued as heretofore. Detailed records for individual plants were kept, and numerous photographs were taken in connection with these investi-

gations. The oil content of a considerable number of samples of seeds from the cotton-breeding plats was determined by the chemist.

In studying the insecticidal efficiency of hydrocyanic-acid gas and carbon bisulphid, chief emphasis was laid during the past year on the investigations with the bisulphid. This work was done in cooperation with the chemist and the botanist. The effects of the gas on plant life and the influence of light and other factors on the resistance of plants treated with the gas were studied.

It was found that the insecticidal power of carbon bisulphid was only a little over 60 per cent and that moisture in relation to its efficiency was not so important as temperature. Both plants and insects were observed to show differences in resistance. In evaporation and diffusion tests with the gas it was found that it had penetrated vertically to 10 feet in depth of shelled corn and cottonseed in 24 hours, but horizontally only 3 feet in the corn. As the height of the container increased, the evaporation of the gas was found to be slower. The rice-weevil investigations included studies of life histories and feeding habits, the effect of weevil injury on the germinating power of corn, and of methods of handling and storing corn to reduce the ravages of the insect. It was found that there is a safe margin of heat between the destruction of the insect and injury to corn. It was also observed that severely cold winter weather reduced the number of insects.

In connection with the study of fertilizer requirements of the soil for cotton by analysis of the cotton plants grown upon it, soil samples were collected from field experiments with the crop in different parts of the State. Analyses were made of cotton plants at the four-leaf stage with special reference to potash. The results secured indicated that on some soils the fertilizers used increased the potash content of the plant much more than on others. For a further study of this project experiments with three types of soils placed in cylinders 20 inches in diameter were begun.

In the study of the effect of different foods upon quality of pork, cottonseed meal, tankage, soy beans, peanuts, corn, and other feeding stuffs were fed, and the fats in the pork produced were studied chemically. Fifty or sixty pigs were used in this work at Auburn, and for the coming year arrangements have been made to carry on this work in cooperation with the Bureau of Animal Industry and to use from 300 to 400 pigs in the experiment. The work on the toxic effect of cottonseed meal on hogs was expanded to include work with 2 horses and 1 mule, which were fed on cottonseed meal and hulls, to which afterwards hay was added. Considerable work was also done with pigs, and the results were studied with reference to their relation to the work of other investigators.

The project on the pathogenic and nonpathogenic flora of the cow's udder was continued, and the results of the work were in part prepared for publication. In the peach-breeding work about 1,800 crosses were made and over 700 set fruits. Spraying work was conducted in connection with the project and the results of lime-sulphur were quite promising. The study of certain physiological functions of the cotton plant included considerable work along anatomical lines.

Progress was also made in the different lines of work carried on with the Hatch fund. The agronomist tested improved varieties of corn and cotton and also made observations on the value of crimson clover for Alabama conditions. The entomologist made studies of miscellaneous insects and gave some attention to the method of facing the boll-weevil problem in Alabama when it presents itself. The botanist studied the guayule rubber plant under a grant from the Carnegie Institution and prepared a report on this work. The botanical department was given space in the new greenhouse. The horticulturist carried on experiments with tomatoes in the greenhouse and the field, and also did field work with potatoes, cabbages, etc., with especial reference to late-grown crops. The horticultural department conducted the nursery inspection with State funds.

The chemist conducted laboratory and field experiments with basic slag made by the open-hearth method. Studies on cane and watermelon sirup were continued. Cylinder experiments with rye, turnips, and other crops were made to determine the effect of decayed nitrogenous matter on the availability of phosphoric acid. The chemist also aided in the fertilizer inspection.

The veterinarian studied a form of paralysis in pigs occurring especially in southern Alabama and appearing to be quite an important factor in the hog raising of that section. Studies on osteoporosis were continued and the results are approaching readiness for publication.

The animal husbandman carried on experiments with beef cattle in cooperation with the Bureau of Animal Industry. The work included the study of methods of maturing beef in winter with the use of foods supplementary to pasturage and silage. In the western part of the State 250 head were fed in this test in cooperation with farmers who furnished the feed and had the profits of the sale. Co-operative experiments with hogs were begun in March, 1910, at an outside point to determine the best use of the field crops of the region. Station feeding tests were made with hogs and sheep in the same way as heretofore. In sheep feeding special stress was laid on the use of cottonseed meal for ewes with reference to the produc-

tion of spring lambs. An account of this work was published in bulletin form.

In addition to the cooperative work mentioned the station followed similar work in the breeding of hardy oranges, and conducted local fertilizer experiments in cooperation with farmers. Assistance was also rendered by the station in farmers' institute work and to teachers of agriculture in the public schools. The more popular work of the station during the year was published through the State department of agriculture, and some of its more scientific work through this department.

The following publications of the station were received during the year: Bulletins 146, Facing the Boll-weevil Problem in Alabama; 147, Crimson Clover; 148, (1) Raising Lambs in Alabama—Maintenance Rations for Ewes, (2) Feeding Cottonseed Meal to Pregnant Ewes; 149, Test of Varieties of Cotton in 1909; and the Annual Reports for 1908 and 1909.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$14, 200. 00
United States appropriation, Adams Act.....	12, 600. 00
Balance from United States appropriations for 1908-9__	1, 200. 00
Farm products.....	965. 60
Miscellaneous.....	763. 83
Total	29, 729. 43

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The experimental work of the Alabama station has apparently increased as compared with former years. The new agricultural building and the new greenhouses give several departments of the institution much better quarters and will contribute materially to the strengthening of the work. There is need of a more definite organization of the extension work and an arrangement for publications along this line.

Canebrake Agricultural Experiment Station, *Uniontown*.

F. D. STEVENS, B. S., *Director*.

No material changes in the management or in the lines and methods of work took place at the Canebrake station during the year.

The principal problems under investigation included a comparison of the agricultural and commercial value of nitrate of soda, the effect of growing alfalfa upon soil fertility, the hay-yielding capacity of the alfalfa crop, the fertilizing effect of bur and crimson clover, cottonseed meal, acid phosphate, and native raw lime rock; the

effect of leguminous and nonleguminous crops on Houston clay soil, and the use of fertilizers on black bottom and poor red land and in connection with continuous cotton culture. In cotton variety tests yields and values per acre were determined on Houston clay of medium fertility and on upland soil of the Canebrake region. Considerable attention was given to the residual effect of the various methods of soil treatment.

The experiments in general showed that the use of nitrogenous manures gave the best results on the soils of the canebrake, and that nitrogen was supplied most economically by alfalfa residues. With these results in view the station recommended rotations in which alfalfa alternates with harrowed crops.

Bulletin 27, *Agricultural Value of Nitrogenous Materials for Cotton on the Houston Clays as Determined by Field Trials, Residual Effect of Cover Crops, Alfalfa Yields, and Effect as a Means of Restoring Fertility*, was received by this office during the year.

The income of the station during the past fiscal year was as follows:

State appropriation..... \$2, 500

The purpose of the Canebrake station is the solution of problems connected with the agriculture of a particular region of the State, and for this reason the institution takes up primarily questions which have a direct and immediate bearing upon the existing farm practices and conditions in the Canebrake region.

Tuskegee Agricultural Experiment Station, *Tuskegee Institute.*

Department of the Tuskegee Normal and Industrial Institute.

G. W. CARVER, M. Agr., *Director.*

The Tuskegee station devoted considerable time during the year to the study of ornamental plants and possibilities of sweet-potato culture, and the development of nature study and gardening for rural schools. A bulletin was published on evergreens and deciduous trees and shrubs, vines, ferns, and other pond, marsh, and bog plants and other miscellaneous species found in Macon County, Ala., and adapted to ornamental planting and landscape gardening in general.

In connection with sweet-potato culture the station studied seed selection, soil preparation, methods of culture and fertilization, harvesting and storing, and various insect enemies and plant diseases attacking the crop. In feeding experiments sweet potatoes were fed to horses, mules, and hogs. The station further gave particular attention to the establishment and manner of conducting nature study and school-garden work, and gave numerous suggestions with reference to the location and preparation of land for school-garden

use, the plants to be grown, and to various other topics relative to carrying out the entire plan of this work. Along agronomic lines the efforts of the institution have been directed toward the increase in the average yield per acre of the common farm crops by means of better cultural processes and the more careful selection of seed.

The officers of the station took part in agricultural extension work among the rural people which the station is intended to serve.

The following bulletins were received from the station during the year: Bulletin 15, Increasing the Yield of Corn; 16, Some Ornamental Plants of Macon County, Ala.; and 17, Possibilities of the Sweet Potato in Macon County, Ala.

The station is maintained by an annual State appropriation of \$1,500. Although its means are limited, the station is exerting a good influence on the agricultural practices of the people it reaches.

ALASKA.

Alaska Agricultural Experiment Stations, Sitka, Kodiak, Rampart, and Fairbanks.

Under the supervision of A. C. TRUE, Director, Office of Experiment Stations, United States Department of Agriculture.

C. C. GEORGESON, M. S., *Special Agent in Charge, Sitka.*

The only changes in the personnel of the Alaska stations during the past fiscal year were the resignation of R. W. De Armond, of the Sitka station, who was succeeded by A. J. Wilkus, a graduate of the Minnesota Agricultural College, and the resignation of H. G. Zoellner, who was for a short time connected with the Sitka station.

A few additions were made to the buildings of the Alaska stations, the principal ones being a 100-ton silo and a horse and sheep barn at the Kodiak station, a combined granary, shop, and implement shed at Rampart, and a combined shop, tool house, and implement shed at Fairbanks.

The plans outlined in former reports have been strictly adhered to. The main lines of work of the Alaska stations are grain breeding for the development of early maturing varieties at the Rampart station; the breeding of horticultural plants, particularly berries and fruits suited to the Alaska climate at Sitka; cattle and sheep breeding at Kodiak; and the growing of general farm crops at Fairbanks, with a view to demonstrating whether or not an average farmer can make agriculture a success in Alaska.

At the Rampart station about 25 acres are now available for experimental purposes. The success previously reported in the growing of cereals at this station, which is located in the Yukon Valley at 65° 30' N. latitude, has been repeated, and it seems to be demon-

strated that hardy early maturing varieties of barley, oats, winter wheat, and winter rye may be grown in the interior valleys of the Territory. Systematic work on cereal breeding is being carried on at the Rampart station, and a number of new varieties of barley and oats have been produced by cross-fertilization, some of which from their limited growth appear very promising. This work will be continued to provide varieties of the more important cereals that are especially adapted to local conditions.

At the Fairbanks station 65 acres are under plow and 40 or 50 acres additional cleared for meadow. The principal line of work during the past year was the growing of oats for forage and grain to determine whether hay and grain can be profitably grown in the interior of Alaska. An experiment on potato growing on a commercial scale was undertaken, and after providing seed for future planting a crop of over 300 bushels was secured.

The stock-breeding work on Kodiak Island has been continued, with the success reported in previous years. The Galloway herd has increased until there are now about 70 head of pure-bred stock in addition to a number of grades. A flock of sheep was added to the live stock of the station during the past year, and seem to be well adapted to the conditions.

The work at Sitka, which has consisted largely of horticultural experiments, has been continued, and marked success has followed the work on the hybridization of strawberries. The station now has a considerable number of locally produced varieties which are hybrids between a wild species and a cultivated sort, and some of these varieties have proved hardy and prolific, with berries of good size and quality. The station continues to test various fruits and berries and is carrying on some work with ornamental plants.

During the past season experiments were conducted at Sitka, Rampart, and Fairbanks in which comparisons were made of the effect of sprouting potatoes prior to planting them. In almost every instance a larger yield of better matured tubers was obtained as a result of a three weeks' exposure of the tubers to light before planting.

The Alaska stations have continued to carry on cooperative work with farmers and gardeners throughout the Territory, and in this way the adaptability of a number of varieties of field and garden plants has been given wide test.

The only publication of the station for 1910 was the annual report.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$28,000.00
Sales and other funds.....	1,802.80
Total.....	29,802.80

The work of the Alaska stations appears to be progressing very favorably, when the conditions under which they labor are considered. The country is developing very slowly, but the settlers are applying more and more to the station for assistance and direction in their plantings.

ARIZONA.

Agricultural Experiment Station of the University of Arizona, *Tucson*.

Department of the University of Arizona.

R. H. FORBES, M. S., *Director*.

The Arizona station continued in general in 1909-10 the lines of work in progress the year before. On the station staff assistants were appointed during the year to give special attention to dry-farming problems and to alfalfa investigations, especially the breeding of strains adapted to the Southwest. W. B. McCallum, assistant botanist, severed his connection with the station at the close of the year to go into commercial work. A. E. Vinson was granted a leave of absence of seven months to go to Europe and continue his studies on the action of enzymes in ripening fruits, and G. E. P. Smith was given leave of absence to make a technical study of pumping devices. The residence building at the Yuma date orchard was enlarged, and laboratory facilities in the university main building at Tucson were increased.

Several of the Adams-fund projects of the station made good progress and some of them were completed during the year. The work on the ripening of dates was practically finished and some of the chemical results have already been published. The analytical work in studying the nutritive value of cacti was also finished, and a report on the chemical and botanical phases of the project will soon appear. A report on the study of the underflow waters of the Rillito Valley, published as Bulletin 64 of the station, presents data regarding the velocity of the underflow, fluctuations of the water table observed in wells, seepage measurements, tests of wells now being pumped, etc., and shows that an adequate and economical supply of water for irrigation can not be obtained by individual pumping plants, but that cooperative pumping enterprises, involving cheap fuel, efficient machinery, deep wells properly located, and skilled supervision of labor, are required to make use of these waters economically. In this connection a cooperative pumping project in the Rillito Valley was designed in detail. This work has now been extended to the Sulphur Springs Valley.

In the line of plant breeding, efforts were made to obtain leafy strains of alfalfa especially adapted to Arizona conditions, and a successful beginning in the development of special strains for the Southwest was made.

The work conducted with the Hatch and other funds was practically the same as in the previous year. A new feature was introduced in the study of about 50 different varieties of beans native to Arizona and Mexico and their use as a basis for breeding experiments. The sheep-breeding work has brought the station flock up to more than 200 animals and in general has shown good results from crossing the Tunis sheep on native range stock. The department of animal husbandry further studied oleander poisoning of stock, and determined the quantity of leaves of this plant required to kill stock. The experiments were carried on with horses, mules, cows, and sheep.

In connection with inspection work, the entomologist studied insects and carried on cooperative spraying experiments. By means of spraying, encouraged by the station in the apple-growing district of eastern Arizona, the apple crop of the last season was saved.

The agronomist made soil-moisture studies, determining the hygroscopic coefficients and the specific gravity of soils sampled to a depth of 8 feet. Experiments with cotton were carried on at Phoenix and Yuma. The tests at Yuma included Egyptian varieties. Native beans were tested under dry-farming and irrigation methods.

The botanist continued the range studies and the results obtained are being prepared for publication. He also made studies of grasses and forage plants with special reference to drought resistance, and of forest trees, shrubs, and other plants adapted to different altitudes within the Territory.

Work in the date orchard was continued in cooperation with the Bureau of Plant Industry. Great differences were found to exist in the fruit of the different varieties. The tendency in some sorts of drying up of the fruit in ripening was observed and the possible relation of methods of irrigation to this matter will be studied. At Tempe there are now about 12 acres in date orchard, and dates are also grown experimentally at Yuma. Olive culture and oil manufacture were studied by the horticultural department and a bulletin was issued on the subject. It is concluded from this work that many varieties of olives under Arizona conditions are well adapted to the production of oil of very fine quality.

Cooperative work, as in former years, was limited to range investigations and date culture in cooperation with the Bureau of Plant Industry. Dry-farming investigations in southwestern Arizona were prosecuted largely by means of funds donated by the El Paso & Southwestern Railroad. Extension work was confined to farmers' institutes supported by Territorial endowment and conducted throughout the Territory.

The appropriations by the Territorial legislature for the biennium beginning July 1, 1909, were given in the report for the previous year.

The following publications were received from this station during the year: Bulletins 59, Oleander Poisoning of Live Stock; 60, Timely Hints to Farmers; 61, Relation of Weather to Crops and Varieties Adapted to Arizona Conditions; and 62, Olive Culture and Oil Manufacture in the Arid Southwest.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
Territorial appropriation, balance from previous year..	12,735.32
Southern Pacific and El Paso & Southwestern Rail- roads, including balance from previous year.....	1,900.71
Farm products.....	1,772.55
Total.....	44,408.58

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The work of the Arizona station is being actively prosecuted with special reference to the needs of the Territory, and the operation of the station is carried on under a systematic and careful supervision.

ARKANSAS.

Arkansas Agricultural Experiment Station, Fayetteville.

Department of the University of Arkansas.

* C. F. ADAMS, B. Agr., A. M., M. D., *Director.*

Considerable progress was made during the year in reorganizing the station and putting its work on a better basis. A department of plant pathology was established and J. L. Hewitt was promoted to be its head. Veterinary science was separated from animal husbandry and made a department by itself, with Wilfrid Lenton in charge. A. K. Short, head of the department of animal husbandry, resigned during the year to take charge of the secondary agricultural school recently established in the second congressional district of the State. Assistants were appointed in entomology, veterinary science, and in agronomy, and the assistant in plant pathology resigned during the year. After the close of the fiscal year, P. N. Flint, of the Georgia station, was appointed animal husbandman, and assistants were appointed in agricultural chemistry, plant pathology, entomology, animal husbandry, and agriculture.

The department of agronomy was improved under its new management, and the work was enlarged and the equipment improved in the department of plant pathology. The need of suitable land for permanent experimental work in agronomy, animal husbandry, and

dairying was temporarily met by renting. Four agricultural schools were provided for by the last State legislature, and the director of the station has a controlling influence in the organization of these schools as a member of their joint board.

The substations were maintained as in previous years, the State providing \$1,000 each annually for these institutions. The last legislature appropriated in all \$35,900 for the use of the college and station for the biennium ending June 30, 1911. In addition, \$10,000 was appropriated for tick eradication.

Satisfactory progress was made in work on the Adams-fund projects outlined in previous reports. The hog-cholera investigations were partially reported upon during the year. It was concluded that pneumonia occurring with hog cholera is generally due to the action of swine-plague bacteria, and is of frequent occurrence unassociated with contagion. It is further stated that all the symptoms and post-mortem lesions of hog cholera of natural origin may be produced by artificially induced cultures of *Bacillus cholerae suis*, and that this artificially induced disease is transferable by cohabitation and by inoculation, but that it then appears in an attenuated form. In the study of toxic principles of cottonseed meal a series of tests to determine the best solvent for the extraction of the meal was made. Further work on this project included a more thorough study of the relative toxic effect of seed from different varieties grown under varying conditions.

The facilities for investigation on the woolly aphis were improved by the addition of an insectary and an experimental orchard. Special attention was given during the past season to the individual life history of the insect and the immunity of apple trees to its ravages. In studying the stages of development, two lines of descent were carried through the season, and from March to October of 1910 14 generations were grown. A comparative study was made of this insect and of similar forms infesting the wild haws. A test was also in progress to determine the reported immunity to the attacks of this pest on the roots of the Northern Spy, about an acre of Northern Spy trees grown on their own roots being devoted to throwing light on this important point.

In the cattle-tick investigations, the life history of the Texas-fever germ has now been quite fully worked out, but certain phases of this problem still await solution. In this connection the methods of hyperimmunization and vaccination were studied. The work on apple-twig blight was well advanced during the season.

In addition to the Adams-fund projects, a large amount of work was carried on in the different departments of the station. The work in agronomy included breeding of corn, wheat, oats, barley,

rice, and cotton; fertilizer, rotation, and culture tests with various crops; and tile-drainage studies. Breeding work with nine standard varieties of corn was carried on for the purpose of combining desirable features to meet Arkansas conditions. Observations were also made on dates and rates of planting, cultivation in different ways, the use of fertilizers, the vitality of seeds, and on the character of plants produced by seed embodying various breeding factors. Fifty varieties of cotton were tested with reference to yield, quality, and length of fiber, early maturity with reference to boll-weevil resistance and adaptability to different sections of the State. Cultural and breeding work with cotton was also carried on. Several varieties each were grown of wheat, barley, and oats for both fall and spring planting to determine the most desirable foundation stock.

The work with rice included a test of 40 varieties, various culture tests, breeding experiments, and a study of methods for the eradication of red rice and for the control of rice blight. Experiments were also made with a large number of leguminous forage crops and with different methods of crop rotation and soil treatment. The department of entomology had charge of inspection of nursery stock. Co-operative experiments in spraying for San José scale indicated that kerosene emulsion may be successfully used to hold the pest in check over summer until lime-sulphur wash can be used. Observations on the occurrence and outbreaks of injurious insects in the State were made, and special attention was given to the life history and methods of control of the plum curculio and the peach-tree borer.

Tick eradication was successfully prosecuted during the year in cooperation with the Bureau of Animal Industry. This work was under the control of the station in the northwestern section of the State and of a commission in the northeastern section. An assistant of the station veterinarian was in charge of the field work. The veterinarian assisted in the eradication of tuberculosis from two local centers in the State, and made post-mortem demonstrations at the State fair on tuberculous animals. Of 363 farms examined, 42 were found to own tuberculous cattle, and of 5,227 cattle tested 69 proved to be tuberculous.

The dairy department increased its facilities during the year by renting an additional 65 acres of land and putting up some buildings. Experiments with silage and soiling crops failed on account of an unfavorable season. Work was continued on the factors controlling moisture in butter, cream ripening versus butter ripening, methods of testing cream, and cooperative herd testing. Experiments in feeding cottonseed meal to brood sows were continued, and some tests were made of the effect of wide and narrow rations on egg production.

The horticulturist tested the effect of fertilizers and topping on the yield of potatoes, of lime-sulphur wash and corrosive sublimate on San José scale, made plantings of asparagus, and tests of top-working apples, in addition to some lines of minor investigation. A test of a variety of citranges made in cooperation with this department proved that the variety under test was not hardy, although *Citrus trifoliata* stock proved satisfactory.

The chemist made some study of acidity of soils and of feeding stuffs sold in the State, as well as analyses of fertilizers, waters, and limestone. The station chemist is also State chemist and examines fertilizers under the State law.

Gratifying progress was made during the year in bringing the college and station in closer touch with the farmers of the State, through cooperation with agricultural and horticultural organizations and by means of various forms of extension work. Considerable cooperative work with farmers was undertaken with a view to encouraging diversification of crops and increasing live stock. Other cooperation included work with the Texas and Tennessee stations upon the effect of climate upon seed and progeny, and with this department and the Louisiana and South Carolina stations in an acclimation test of rice. This work was in addition to the work mentioned under horticulture, live-stock inspection, and tick eradication.

The following publications were received from this station during the year: Bulletins 104, Farm Drainage; and 105, Studies on the Bacteriology of Infectious Swine Diseases.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	13, 000. 00
State appropriation.....	20, 942. 31
Balance from previous year, State appropriation.....	24, 264. 50
Fees	31. 50
Farm products, including balance from previous year...	20, 132. 10
Total	93, 370. 41

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Arkansas station, although with limited funds at its disposal, made decided progress during the year in the reorganization and development of its work and in the dissemination of its results throughout the State. The improvement in organization and equipment, if coupled with greater financial assistance by the State, would place the institution in position to meet to better advantage the demands made upon it by rapidly growing agricultural interests.

CALIFORNIA.

Agricultural Experiment Station of the University of California, *Berkeley.*

E. J. WICKSON, A. M., *Director.*

During the year the station came into possession of the new farm at Fresno, known as the Kearney tract, which includes 5,400 acres with fine buildings, and is valued at about \$1,000,000. Some experiments were inaugurated there. The branch station at Tulare was discontinued, temporarily at least, in January, 1910. Preliminary work, for which a State appropriation of \$6,000 was available for the biennium, was actively carried on in different parts of Imperial Valley. The studies at the laboratory at Whittier, near Los Angeles, were continued as a regular part of the station's activity, and considerable field work was done in other sections of the State. On the Davis farm a horse barn, sheep barn, horticultural building, veterinary clinic, poultry plant, and an addition to the seed house were built during the year. The forestry stations at Santa Monica and Chico are conducted with a grant of \$1,200 for each station, which is inadequate for efficient maintenance.

Satisfactory progress was made in the Adams-fund work in general. The study of the relation of marly soils and of lime to chlorosis of citrus fruits seems to have indicated that no relation exists between lime and chlorosis, but that the marl layer, through its effect on water conditions, may influence the prevalence of chlorosis. It was found in making excavations under the trees for the purpose of getting the profile of the marl bed that the injury from chlorosis was apparently greatest in the depressions. The project on the toleration of alkali was about completed during the year. The work embraced a study of tolerance by individual plants and by varieties, and special attention was given during the past season to eucalyptus trees.

In the study of soil bacteria under arid conditions the effects of various salts of the soil in relation to bacteria were observed, and the application of certain salts to overcome the toxic effect of alkali on both bacteria and plants as a practical method of treatment was considered. The study of soil columns in connection with this work revealed the fact that nitrifying bacteria are found down to a depth of 12 feet, while in humid soils they are mostly in the first 4 or 6 inches.

The project on environment in relation to gluten content of cereals was transferred from Ceres and Tulare to Davis and Fresno. The soil from Kansas gave no special result, indicating that the soil is not a factor in determining the gluten content. Hardness and high gluten content are apparently due to climatic influence. On the same soil the gluten has been found to vary a good deal from year to year, owing evidently to the time and quantity of rainfall. The

effect of holding down the winter temperature, reducing sunshine, changing the time of planting, and the influence of similar other agencies were also studied in this connection.

A lot of seedling walnuts from various parts of the State, studied with reference to type, were budded with English walnuts to determine the effect on the stock, and observations were made on crosses of oak on walnut to ascertain whether the "walnut oaks" found growing wild in parts of the State are the result of a cross or must be otherwise accounted for. This work was in progress at Berkeley and near Los Angeles.

The work on *Nicotiana* hybrids was followed according to the original plan. About 1,200 individuals representing different sorts, types, and strains have now been produced in these experiments, which have been conducted to some extent in cooperation with this department. In the first generation close observations were made for the purpose of adding to our knowledge of the law of hybrids and if possible securing results of practical value in tobacco breeding.

The investigations on the control of the scales of the citrus trees were largely confined to tent fumigation with cyanid. The leakage from common tents was determined and the dose for fumigating for young black, red, and purple scales, allowing for leakage, was worked out. New and simple methods and apparatus were devised for scheduling trees in the field and thus determining the size of tree and the tent room and material required for successful fumigation. The effect of humidity, temperature, wind, and similar factors on the efficiency or leakage was also taken into consideration. The study of the life history and classification of the citrus scales was carried on as a separate project, and breeding work was pursued with a view to turning yellow scales into red and vice versa in the successive generations by change of environment and other influences.

A thorough study was made of the life history of the Argentine ant, its manner of spreading, and methods for its control. Good results were secured from the use of bait treated with arsenical poisons, and with cresol and kerosene in combating the insect. It was observed that the Argentine ant spread slowly as the queens do not mate in the air, but owing to the large number of queens it is very prolific. The facts seem to indicate that the extermination of the ant is a possibility, and work was begun to determine the practicability of stamping it out in a given locality. As the research features of this investigation have now passed, the work will be discontinued as a research project. The study on the toxicity of the various arsenical poisons used as insecticides was interrupted by the appearance of the Argentine ant but will be taken up again.

The artificial immunization of cattle against tuberculosis was continued on the farm at Davis, and some of the results were reported

last year in the Proceedings of the American Veterinary Medical Association. Under California conditions the use of bovovaccine seemed to produce some immunity, but to fail in protecting calves until $2\frac{1}{2}$ years old. It was also found that tuberculosis sometimes spreads rapidly in cattle under strictly outdoor conditions. The retesting of cattle within six weeks, even when Vallée's method was used, was unsatisfactory, as it was observed that some tubercular cattle will not react to tuberculin on retesting even after three months. Guinea-pig inoculations with the blood sediments of 20 tuberculous cattle failed to produce tuberculosis. Tubercle bacilli experimentally thrown into the blood streams were rapidly removed from the circulation, which is regarded as indicating that the capillaries of the lungs are more efficient in arresting bacilli than the peripheral capillaries.

The cause of sterility of almond trees was further investigated, numerous microscopical studies of the pollen of many varieties being made in the laboratory and in the field. It was brought out by these studies that the pollen of the better varieties of almonds, known as the Hatch varieties, is almost uniformly physically imperfect, while pollen of such varieties as Drake Seedling and Texas Prolific, as well as that of certain nameless seedlings, was found regular in form, plump and well rounded. These facts are believed to explain the noted self-sterility of the Hatch varieties and the reputed value of Drake Seedling and Texas Prolific as cross-pollenizers. These conclusions were largely confirmed by the results of field experiments. The experimental plantings of almonds have been increased to 16 named varieties, planted in groups of five. These plantings, as well as the laboratory, are located at Davis.

A number of different lines of work were prosecuted with funds provided through the Hatch Act and State appropriations. Breeding work with individual wheat plants for nitrogen and also for yield were conducted, together with experiments on green manuring with field peas in wheat culture. One object in view is to overcome the apparent necessity of practicing bare fallow. At present the station fields average 36 bushels, the land being fallowed every other year. Variety and culture tests with various crops were also in progress at Davis, and some work on cotton was pursued in the Imperial Valley.

The entomological department cooperated in the study on the phylloxera and also gave attention to the control of the peach-tree borer, thrips, and mosquitoes. One of the county entomologists, cooperating with the department, found that banding the trunks with asphaltum is very effective in controlling the peach-tree borer. Spraying heavily with lime gave good results in combating thrips.

In plant pathology, work was begun on the olive knot and the root rot or toadstool disease on citrus, almond, peach, and old oaks. Under a grant of \$15,000 secured from the legislature of 1908-9 for pathological work in the northern part of the State, attention was given in a general way to pear, apricot, and peach diseases and methods of their control.

The cooperative work of the station included the selection of Lima beans with growers of this crop, investigations carried on by county entomologists associated with the entomological department of the station, and irrigation work in conjunction with this office, comprising the effects of different amounts of water for alfalfa, and the evaporation of water from tanks and from the soil. A demonstration train was sent out from April 4 to 16, traversing about 700 miles of the Southern Pacific system. It was manned by experts from the college and station staff and fitted up with illustrative material from the different departments.

The following publications were received from this station during the year: Bulletins 202, Commercial Fertilizers; 203, Report of the Plant Pathologist and Superintendent of Southern California Stations, July 1, 1906, to June 30, 1909; 204, The Dairy Cow's Record and the Stable; 205, Commercial Fertilizers; Circulars 40, California State Farmers' Institute at the University Farm, Davis; 41, The School of Agriculture on the University Farm, Davis, Cal.; 42, Pacific Coast Entomological Conference and Special Short Course in Horticulture; 43, The School of Agriculture on the University Farm, Davis, Cal.; 44, Opportunities for Instruction in Dairy Industry at the University Farm, Davis, Cal., 1909-10; 45, Announcement of Farmers' Short Courses for 1909 at the University Farm, Davis, Cal.; 46, Suggestions for Garden Work in California Schools; 47, Agriculture in the High Schools; 48, Butter Scoring Contest, 1909; 49, Insecticides; 50, Fumigation Scheduling; and 51, University Farm School, Davis, Cal.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation.....	175,480.22
Fees	17,007.40
Farm products	41,958.35
Balance from previous year.....	4,090.98
Miscellaneous.....	27,541.15
Total	<u>294,078.10</u>

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The California station has a great field, unusually diverse, and offering remarkable opportunity for study and for the introduction of scientific methods in working out the various problems of different localities and industries of the State.

COLORADO.

Agricultural Experiment Station, Fort Collins.

Department of the State Agricultural College of Colorado.

C. P. GILLETTE, M. S., *Director.*

Several changes in the personnel and improvement in equipment were made at this station during the year. Administrative difficulties which had been arising for some time culminated in the retirement of Director L. G. Carpenter at the close of the year and the appointment of C. P. Gillette, the station entomologist, as his successor. H. M. Cottrell and H. M. Bainer left the station to enter other lines of work, and J. C. Summers and C. E. Vail were appointed to take up work under the station chemist. The new irrigation engineering building was completed and about one-third of the available space was designed for the use of the station. A number of buildings to be used in poultry experiments and costing about \$2,000 were erected, and a model potato cellar costing about \$800 was constructed.

Work on most of the Adams-fund projects undertaken by the station was continued during the year, and some of the results were published. The project on the waters of the San Luis Valley developed into two important studies, i. e., nitrogen fixation and nitrification in alkali soils, and the arsenic content of soils where spraying is practiced and the relation of alkali to the arsenical poisoning of fruit trees. These now constitute separate projects. Attention was centered on the excess of nitrates found in certain soils popularly classed as black alkali, the bacteriologist of the station cooperating. The effect of excessive amounts of nitrates in soils on the quality of sugar beets was studied on a 12-acre tract of beet land in the Arkansas Valley.

Bacteriological work under this fund was also done on a new alfalfa disease, on a disease of raspberry known as yellows, and on the hold-over blight in pear and apple trees. As stated in a bulletin on the subject, the new alfalfa disease called stem blight, and known in Colorado since 1904, is caused by a germ (*Pseudomonas medicaginis*) which apparently enters the plant through stems cracked or split by freezing. A description of this disease was made and

means of control were recommended. The study of the raspberry yellows was made on material grown at Loveland, and while it is thought that a remedy has been found the work is to be continued another season.

The principal question under investigation with reference to the hold-over blight in pear and apple trees is the resistance of these germs to the severe winters of Colorado. Observations were begun by the botanist on the black rot of the strawberry to determine whether this is caused by winter injury or whether it is due to some soil organism. The work has thus far been conducted in the greenhouse but it is proposed also to make field culture experiments. The investigations on plant lice were actively continued and satisfactory progress was made.

In addition to the Adams-fund work numerous Hatch-fund projects were carried on. Considerable work was done on the correlation of characters in wheat, oats, and barley, and alfalfa breeding was conducted in a large alfalfa nursery at Rocky Ford, where many distinct varieties of alfalfa are grown, and where a promising strain has been developed. On the Plains region in eastern Colorado, experiments were carried on in different localities with durum wheat, corn, and forage crops. Special experiments with methods for diminishing the effect of winds on the movement of soils were tried, and studies of farm management to determine the feasible methods of dry farming in this region were made. The work in agronomy was largely maintained with State funds.

The entomological department carried on work with reference to the codling moth, potato insects, and other insect pests. An orchard of about 900 trees planted a few years ago principally for the purpose of determining the injurious effects of crown gall and woolly aphids upon the crown and roots of small trees, was used this year in connection with spraying experiments for the destruction of plant lice. The codling-moth work was essentially a comparison of arsenate of lead and sulphate of arsenic for the destruction of this insect. The injurious effects of these substances on the foliage was also observed. Some cooperative work along this line was carried on with orchardists throughout the State, and a few minor insect pests received attention. In the study of potato insects special attention was given to the Colorado potato beetle and the cucumber flea beetle.

The horticultural experiments were supported by the Hatch fund and a State appropriation of \$10,000 for the biennium, and much of the work was done in different parts of the State. The principal crops receiving attention were asparagus, raspberries, cauliflower, cabbages and other vegetables, and apples. Experiments were con-

ducted at the station and on the west slope with cover crops for orchards as a means of adding humus to the soil. The work with cabbages was largely confined to growing plants from seed of known parentage for comparison, with the hope of developing a strain specially suited to meet Colorado requirements. In connection with bean-breeding experiments, several selected varieties were grown in the greenhouse and cross-fertilized. The resulting hybrids are compared in field-culture tests. A model potato cellar was installed at the station for experiments in storage.

The animal-husbandry work was entirely supported by State funds, and included feeding experiments in which different rations for sheep, hogs, and steers were compared. In the sheep-feeding experiments it was found that it is profitable to use alfalfa hay of the best quality. In steer-feeding work molasses, cottonseed meal, and beets made a cheap and satisfactory ration. As a rule, purchased grain rations were not found profitable and it was necessary to use home-grown feeds. The animals used in these experiments were in some cases furnished by commission firms.

The poultry work of the station is supported with a State fund of \$5,000, including work at farmers' institutes and poultry shows. During the year different types of colony houses suited to local conditions were tried, and data on the profit of the poultry business in Colorado were collected.

The irrigation work of the station included meteorological studies, drainage survey of the State, observations on seepage and return waters, and concrete for minor constructions. Most of the irrigation projects have been in progress for a number of years, but the data secured have not yet been published.

The station cooperated with farmers in the State in a number of lines of work, especially investigations with reference to predaceous insects and horticultural work of various kinds. With this department cooperative work was carried on in horse breeding, field dairy work, forestry work on the plains of Colorado, and the construction of a piece of model road. Much of the orchard work upon the western slope, as well as of the potato work, is in the nature of college and station extension efforts.

The following publications were received from this station during the year: Bulletin 146, Raising Hogs in Colorado; 147, Top-working Fruit Trees; 148, Cement and Concrete Fence Posts; 149, Carrying Range Steers Through the Winter—Sugar Beets for Fattening Steers; 151, Ration Experiments with Lambs, 1906-7, 1907-8—Self-feeders for Hay; 152, Two Common Orchard Mites; 153, Agricultural Products Shipped into Colorado in 1909; 154, Alfalfa Studies; and 155, The Fixation of Nitrogen in some Colorado Soils.

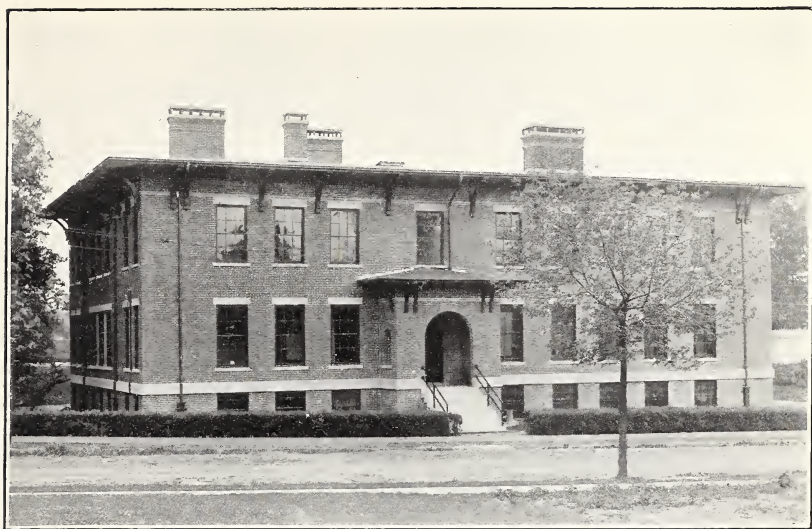


FIG. 1.—NEW LABORATORY BUILDING AT THE CONNECTICUT STATE STATION.



FIG. 2.—MAIN BUILDING OF THE FLORIDA STATION.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation-----	52,500.00
Balance from previous year, State appropriation-----	2,475.00
Miscellaneous-----	20,103.84
Total-----	103,078.84

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The work of the Colorado station has considerably broadened in recent years as the result of State appropriations, and more definite effort is being made to meet the needs of the different parts of the State. As the administrative difficulties encountered are being overcome the institution is placed to better advantage with reference to the extension of its influence in general and the progress of its investigational work in particular.

CONNECTICUT.

The Connecticut Agricultural Experiment Station, *New Haven.*

E. H. JENKINS, Ph. D., *Director.*

During the past year the Connecticut station suffered a serious loss in the destruction of one of its laboratory buildings. The fireproof addition to one of the laboratories (Pl. I, fig. 1), as mentioned in last year's report, was under construction, and when the walls of this addition were nearly completed the laboratory to which it was an addition was destroyed by fire, January 10, 1910, but very little damage was done to the new structure. The most serious items of loss were the very valuable chemical library and animals which had been under experiment for five months. The burned building has been rebuilt at a cost of about \$17,500 and made uniform with the new one, and also fireproof in its construction. As a result the station has now a large, well-equipped, thoroughly fireproof structure for the safe storage of its valuable collections.

The State appropriations for the biennial period, not including the amount allowed for the laboratory building, were \$2,000 for maintenance, \$5,000 for food inspection, \$6,000 for the department of entomology, and \$2,000 for the State forester's office.

The investigations under the Adams fund, as in previous years, included the project on vegetable proteids, which is in part supported by a grant of \$5,000 from the Carnegie Institution, and the work in plant breeding. The work on the vegetable proteids was seriously

disturbed by the burning of the laboratory, but no important records were lost and the work has progressed during the year. The principal lines of study this year included the experimental feeding of white rats to determine the relative food value of different vegetable proteins. These animals were fed for long periods under conditions heretofore considered impossible. Attention was further given to the study of methods for determining the proportion of the products of hydrolysis of proteins. The results of this work were written up in three papers in the *American Journal of Physiology*.

During the year three other comprehensive and important publications were issued by this department. A volume entitled "The Vegetable Proteins" describes the more important characters of the vegetable proteins, reviews the work in the entire field, and includes a practically complete bibliography of the chemistry of these substances. The second publication is a contribution to the *Handbuch der biochemischen Arbeitsmethoden*, and is entitled "Darstellung der Proteine der Pflanzenwelt." This is a detailed description of the methods for preparing the various vegetable proteins in the highest state of purity. The third publication, *Die pflanzlichen Proteine*, is a critical review of the literature of the vegetable proteins, bringing the same into orderly arrangement and indicating the relative values of the various published observations.

The plant-breeding work with corn and tobacco was continued, and studies were made to determine the application of the laws of heredity to these crops. Some work was also done in the improvement of the potato by breeding. The tobacco plant was found exceptionally well adapted to this line of investigation on account of its abundant seed, which is set either by close or cross fertilization.

The greater part of the work of the station was carried on by Hatch, State, and the Lockwood funds and fees, and in cooperation with this department, especially with the Bureau of Plant Industry and the Forest Service. In the forestry department a detailed study of the management of second-growth hardwoods was made, and over 250 sample plats in typical woodlands were selected by the department for the measurement of trees and of felled timber. The results of this work are to form a basis for making yield tables showing the production of different types of forest at different ages. Permanent sample plats were established on the State forest land, and measurements were periodically made to determine the results of different methods of forest management. The effect of different thinning and the best method of developing profitable growth of hardwoods were studied in this connection. The department is also making an effort to find some hardwood species that will replace the chestnut, which is being rapidly destroyed by disease. An experimental thinning of a 30-year old plantation of white pine was also

begun. Through the agency of the station a modification of the fire laws has been secured.

In cooperation with the Bureau of Plant Industry of this department, studies on tobacco are in progress near Hartford, in which the effect of large amounts of phosphate in tobacco fertilizers and a comparison of the method of harvesting broad-leaf tobacco by picking or priming by the usual method of harvesting the whole plant are receiving attention. This work has demonstrated the desirability of certain changes in tobacco fertilizers, and the value of steam sterilization of tobacco beds which destroys fungus diseases and makes weeding of the beds unnecessary.

The plant pathologist pursued numerous lines of work, including investigations on peach yellows, sun scald of trees, blight of Lima beans, potato blight, tobacco diseases, etc. The experiments on the calico or mosaic disease of tobacco indicated the extremely infectious nature of the malady and its being an enzymatic disturbance. An experiment on a plat of 900 peach trees was made to determine the relation of fertilizers to peach yellows. A large number of spraying experiments were conducted to find the most efficient methods for the control of plant diseases and the specific action of Bordeaux mixture. Field work was carried on with cowpeas and alfalfa to test the value of artificial inoculation. Some plant-breeding work was done, principally with hybrid varieties of corn and for disease resistance in melons, cucumbers, etc. A report of tests of summer sprays on apples and peaches, conducted by the botanist and the entomologist, was issued during the year.

The entomologist gave much attention to gipsy-moth control, and reported the practical extermination of this pest at Stonington and the control of the infested area at Wallingford. Cooperative work was carried on with the Bureau of Entomology of this department on the foreign importation of gipsy-moth parasites. The last legislature provided for a bee inspection and assigned the work to the entomologist of the station.

The chemical department, in addition to its extensive inspection work, carried on studies of the various ammoniates in fertilizers in field and in pot cultures. The control work of the station, in addition to the bee inspection mentioned above, includes nursery inspection, the analysis of fertilizers, feeds, food products, and drugs, and the testing of seeds.

The station took an active part in the various agricultural fairs of the State, exhibiting its work in a large tent. The exhibits and lectures attracted a great deal of attention. No other extension work was undertaken by the station.

The following publications were received from this station during the year: Bulletins 164, Garden and Field Seeds Sold in Connecticut

in 1908-9; 165, The San José Scale and Methods of Controlling It; Annual Report for 1907-8, part 12, Report of the Station Botanist, 1908; and Annual Report for 1909-10, parts 1, Fertilizers, 1909; 2, Food and Drug Products, 1909; 3, Commercial Feeding Stuffs, 1909; and 4, Ninth Report of the State Entomologist, 1909.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$7,500.00
United States appropriation, Adams Act.....	6,500.00
State appropriation.....	18,500.00
Individuals.....	8,817.18
Fees.....	10,300.00
Farm products.....	160.81
Miscellaneous.....	594.42
Total.....	52,372.41

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

Lines of work at the Connecticut station of much interest to science and of high value to practical agriculture are pursued steadily, and are gaining for the institution the increased confidence and loyal support of the people of the State.

Storrs Agricultural Experiment Station, Storrs.

Department of the Connecticut Agricultural College.

L. A. CLINTON, M. S., *Director*.

No new lines of work were taken up during the year at the Connecticut Storrs Station, and aside from satisfactory progress no changes occurred in the different lines of investigation. The biennial State appropriation for the use of the station amounts to \$4,000. The station staff remained practically the same as the year before.

The Adams-fund projects in hand were carried forward during the year and a report on some of the work was made. A preliminary report on the bacillary white diarrhea of chicks was made in Bulletin 60 of the station, which states that the specific causative agent is the organism *Bacillus pullorum*. The disease was found to have fairly uniform symptoms and post-mortem appearances. Chicks were infected by subcutaneous injection with pure cultures of the organism and the disease was also transmitted through infected food supply. The original source of infection seemed to be the mother hen, and a certain percentage of the chicks in infected places were observed to have the disease when hatched. The disease seemed most prevalent among artificially hatched and brooded chicks, but hen-hatched chicks were not found to be immune.

The cheese investigations were continued, special attention being given to troubles encountered in the manufacture of Roquefort cheese. In a study of the specific action of salt on the organisms in Roquefort cheese it was found that it does not inhibit the growth of *Penicillium* but does check the growth of *Oidium lactis*. The work of breeding beans and melons for disease resistance was pursued as previously outlined. With beans certain color correlations in stems, flowers, etc., have been established in this connection. The relation of lactic-acid bacteria to cheese making and the bacteriology of incubating eggs were given further attention, and the part played by micro-organisms in silage fermentation was studied. Biological soil studies were also taken up during the year.

Among the lines of work carried on with the Hatch and other funds were farm management experiments, feeding experiments with cows for milk production, feeding of high and low protein rations for cows, ice-cream studies to determine the nature of the overrun, testing cream for age, acidity, etc., as influencing the quality of ice cream, supervising the testing of cows for advanced registry (at the expense of owners), studying the lime factor of soils, culture experiments with corn, introduction of alfalfa, and determining the efficiency of lime-sulphur spray on potatoes. The chicken-breeding experiment for the production of a breed of hens having superior size and vigor and which lay white eggs was continued, and an experiment on the cost of feeding heifers in the college herd from birth to 2 years old was completed.

The cooperative work of the station is limited to the cheese investigations, which are carried on with the Dairy Division of the Bureau of Animal Industry. The extension and demonstration work is largely confined to orchard management and is done by the college, station men as a rule giving little time to this feature.

The following publications were received from this station during the year: Bulletins 56, Control of Insects and of Plant Diseases; 57, A Study of Some Connecticut Dairy Herds; 58, Camembert Cheese Problems in the United States; 59, *Bacterium lactis acidii* and its Sources; 60, Bacillary White Diarrhea of Young Chicks; 61, Apple Growing in New England; 62, Apple Growing in New England; 63, The Cost of Feeding Heifers; and the Annual Report for 1908-9.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$7,500.00
United States appropriation, Adams Act.....	6,500.00
State appropriation.....	1,950.00
Miscellaneous.....	701.84
Total.....	16,651.84

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The work of the Storrs station is steadily prosecuted along several important lines, and the results secured are proving valuable to agriculture in general as well as to the agricultural industries of the State.

DELAWARE.

The Delaware College Agricultural Experiment Station, *Newark*.

Department of Delaware College.

H. HAYWARD, M. S. Agr., *Director*.

No important changes in this station took place during the year. The farm purchased by the State a few years ago is entirely under the control of the station, practically all of it being employed either for experimental purposes or for supplying feed for the work stock. The State appropriated \$10,000 for farm buildings, with which a new barn was recently completed, a new silo erected, and the old barn reconstructed.

Considerable progress was made on some of the projects supported by the Adams fund. The work relating to the functions of tannin in plants was practically completed. This investigation has brought out the inhibitory effect of tannin on the germination and growth of spores of many species of fungi. The results seem to indicate further that the action of tannin is complicated by the presence of enzymes in plants.

The horticultural department continued its work on the functions of nitrogen, phosphoric acid, and potash in the growth of apple and peach trees. Leaves were collected for analysis and measurements of growth were made. It is believed that some differences, due to the kind and amount of fertilizer applied, can be noticed with peaches, while with apples no results have thus far become apparent. The study of the effect of the different fertilizers on bud production of peaches is to be taken up.

The veterinarian did no further work on glanders and concluded his investigations on anthrax, the results of which are regarded as showing the possibility of bringing about passive immunity through inoculation with serum. It is claimed that an immunizing serum producing immediate immunity from anthrax, which can be used in controlling the disease in cases of outbreaks, and a single vaccine of practical value and reducing the time in gaining immunity by one-half, have been secured as a result of this work. A bulletin giving the results in detail was prepared. Experiments on in-and-in breeding with dairy cattle was begun by the station during the year, and a study of the effect of variations in physical characters and chemical

composition of the corn kernel upon the vigor of the plant was taken up.

Under the Hatch fund the plant pathologist tested seeds, studied a *Botrytis* disease of roses, and began work on a bud study of peaches affected with yellows. The efforts of the horticulturist included numerous variety tests of orchard fruits and vegetables, fertilizer and rotation experiments with potatoes and tomatoes, and tests of fertilizers and cover crops in orchards.

In agronomy the work included variety tests of corn, wheat, oats, cowpeas, soy beans, and other crops, and fertilizer studies with commercial lime and stable manure in connection with four-year rotation experiments with corn, wheat, oats, and grass. The value of different forms of lime and phosphorus for crops and the stooling habits of about 60 varieties of wheat were also studied. Decided differences were found to exist among varieties of wheat in their response to fertilization and in the quantity of phosphoric acid, potash, and lime taken up. It was further observed that some difference is apparent in the effect of the various forms of lime on the decomposition of organic matter in the soil.

Further data in the continued study of crimson clover, with reference to its rate of gaining nitrogen, show that the crop may gain nitrogen rapidly during the last month preceding its bloom, in some cases, while in others it gains little. Crops yielding much nitrogen a month before full bloom were found, as a rule, to gain fewer pounds during the last month than crops poorer in nitrogen at this stage. Approximately each additional pound of nitrogen at the earlier period reduces the later gain by about one-half pound. It is stated that a fall growth of crimson clover may furnish 50 to 100 pounds of nitrogen per acre and be profitable even though the crop is winter-killed, and that the first month's growth in spring usually produces about one-third of the final yield of nitrogen. It was determined that when the crop was removed 35 to 40 per cent of the nitrogen is left in stubble and roots.

The entomologist studied the life history of the apple-leaf miner and the blackberry-leaf miner and gave some attention to methods of their control. The most efficient method for the control of the apple-leaf miner consisted in the destruction of the larvæ or pupæ while in the leaves on the ground by burning or smothering. This insect is now generally controlled in infested orchards by plowing under all infested leaves in the fall or early in the spring before the moths emerge. Gathering and destroying the infested leaves, especially those of the first brood of the blackberry-leaf miner, is considered the most feasible method of combating the pest.

In work on the curculio it was found that three sprayings of arsenate of lead were equally as valuable as the same number of sprayings

with self-boiled lime-sulphur used with the arsenate. It was further found that self-boiled lime-sulphur used without arsenate of lead gave practically the same results as where the two substances were applied together. The spraying with arsenate of lead alone prevented a large amount of injury by the curculio. Spraying with self-boiled lime-sulphur filled the wounds made by the curculio and thus prevented the growth of spores in these wounds.

The veterinarian did some work in testing commercial toxins and antitoxins, and began an investigation of autogenetic serums. Some work was also done for the State board of agriculture on hog-cholera serums. The animal husbandman reported that in in-and-in breeding experiments with hogs thus far no evil effects have been noticed.

The station has no definite cooperative work with farmers or other stations, but the station veterinarian is working in cooperation with this department. No well-defined extension work is done, as funds have not been provided for it, but occasionally members of the staff deliver addresses at institutes or farmers' gatherings. On Farmers' Day, June 13, 1910, a large number of visitors inspected the station.

The following publications were received from this station during the year: Bulletins 86, Crimson Clover—Its Rate of Gaining Nitrogen; 87, Two Important Leaf Miners; and 88, Annual Report of the Director for 1909.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
Farm products.....	608.42
Total	28,608.42

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Delaware station is making good use of the funds at its disposal in the conduct of experiments and investigations of substantial character. Its relations with the instruction work of the college are such as to allow its staff to devote their attention very largely to the station activities.

FLORIDA.

Agricultural Experiment Station of Florida, *Gainesville*.

Department of the University of the State of Florida.

P. H. ROLFS, M. S., *Director*.

At the Florida station the year was marked by further improvement in equipment and general progress in the lines of investigation pursued. The new station building provided by the State at a cost

of \$47,500, including equipment, was practically completed (Pl. I, fig. 2). This 3-story brick building provides quarters for the station staff and for the extension and farmers' institute force. All of the experimental work of the station is organized on a project basis, each project being submitted to the director for approval before being taken up. A number of changes, mainly in the minor positions on the station staff, occurred during the year.

Progress was made on all Adams-fund projects. In the soil-project work the pineapple investigations were practically brought to a close. A bulletin published on the study reports that the amount of sugar and acid in the juice of pineapples is not sufficiently affected by the fertilizer used to influence the eating quality of the fruit. The large fruits examined contained a greater percentage of sugar and a slightly smaller percentage of acid than was found in the small fruits, and the ratio of reducing sugars to sucrose was greater in the large fruits than in the small ones. In addition to securing these results a survey of the principal pineapple soils of the State, including the analyses of soil samples from nearly all of the pineapple-growing sections, was made. Seventeen varieties of pineapples were described and 12 varieties were analyzed.

The results of fertilizer experiments further showed that fine-ground steamed bone and slag phosphate were the best sources of phosphoric acid; cottonseed meal, dried blood, and castor pomace, the best sources of nitrogen; and high-grade and low-grade potash, the best sources of potash. The analyses of a large number of pineapple plants showed that they contained sufficient plant food to make them valuable for fertilizing purposes. The nitrates in the soil increased with an increase of nitrogenous fertilizers and were found most abundant at the immediate surface, the amount below 1 foot in depth being very small. Where the surface of the ground was not protected, the nitrates were much less abundant than where plants and decaying leaves covered the soil.

Similar work to that with pineapples was inaugurated with citrus fruits at Lake Harris, where favorable soil and climatic conditions prevail (figs. 1 and 2). Additional problems studied in these experiments were the influence of organic fertilizers on the quality of oranges, the proper time for the application of fertilizers, the effect of lime on the quality of fruit and on the availability of phosphoric acid applied as a fertilizer, and the effect of clean culture. Observations were also regularly made on air and soil temperatures and on rainfall.

Studies of scaly bark, gummosis, and stem-end rot formed the more prominent features of the work on the diseases of citrus trees undertaken the past year. It was found that both scaly bark and stem-end rot are due to fungus attacks. The investigation of the

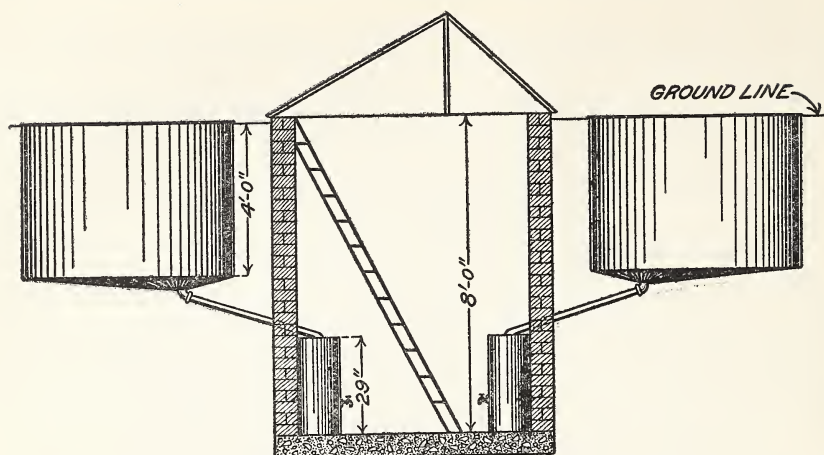


FIG. 1.—Tanks for soil investigation at Florida station—section. The tanks are of heavy galvanized iron, 5 feet $3\frac{1}{4}$ inches in diameter, with a maximum depth of $4\frac{1}{2}$ feet, painted within and without, and a surface area of $\frac{1}{2000}$ acre.

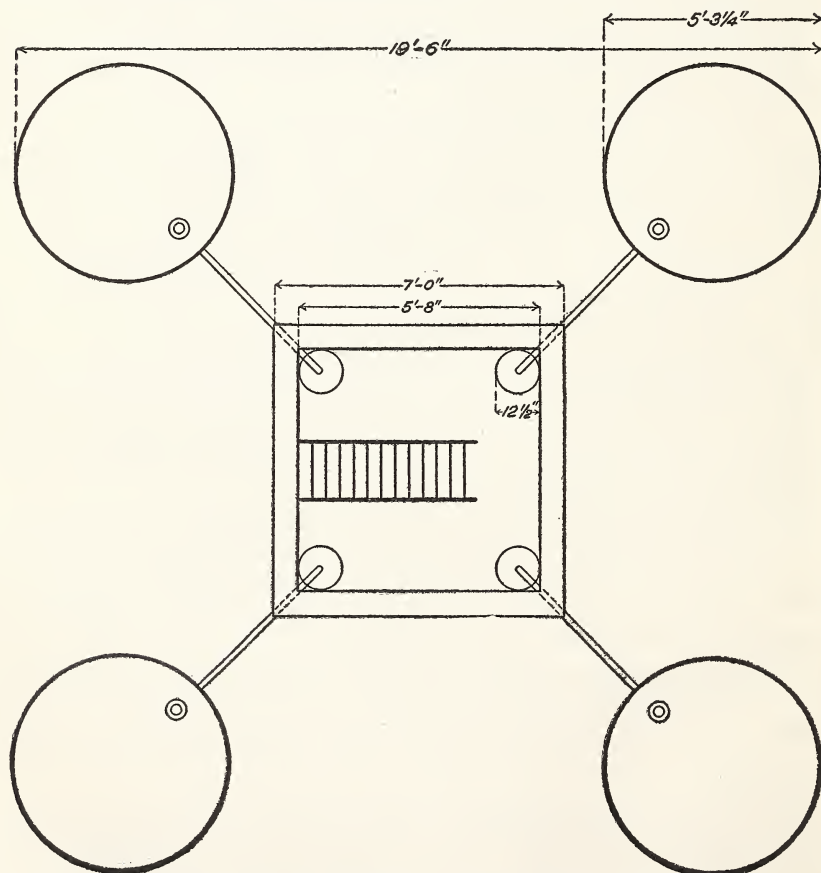


FIG. 2.—Tanks for soil investigation at Florida station—general plan.

scaly bark disease included field and laboratory operations and co-operative experiments on 200 trees, and was about completed for the final report, a preliminary report having been made a year ago.

The plant physiological investigations were carried on from the standpoint of nutrition and malnutrition. The results of the nutrition studies gave evidence of the toxicity of nitrate of soda to the citrus tree when applied in maximum amounts, and of the counteraction of this toxicity by the use of acid phosphate. The malnutrition studies included the citrus diseases known as melanose, die-back, and yellow spotting. About 2,500 microscopic slides of healthy and diseased tissue were prepared and studied in part. Chlorosis of cassava was also investigated by this laboratory. Results indicate the disease to be physiological, brought on by certain unfavorable soil conditions, and that it may be prevented by planting upon a rich soil to insure a more favorable growth.

Work on the white-fly project was continued. Spraying experiments showed that the fly was most readily destroyed by the use of weak solutions at an early stage in its life history. Experiments were made on a large scale by spraying and applying fungi in orchards for the purpose of determining to what extent the insect may be controlled by the use of fungi which attack it. It was found that spring and fall spraying is more effective than winter spraying, and that the use of the fungi costs much less than the application of insecticides. In the hottest weather, however, spraying with insecticides was more effective. In the pupal stage the insect was apparently immune to fungus attack. The use of laundry-soap solutions was found effective against the fly. A second species of white fly was distinguished and additional food plants of the insect were discovered.

Work in plant breeding was begun as a new project. This new work is carried on with the velvet bean and its allies and with corn.

The work carried on with the Hatch fund was largely along lines of animal husbandry and agronomy. Feeding experiments were made for beef and milk production. In feeding for beef, a ration consisting of 8 pounds of corn, 10 pounds of cottonseed hulls, and 12 pounds of velvet beans in the pod gave an average daily gain of 2.92 pounds per head for a period of 84 days at a cost of $7\frac{1}{2}$ cents per pound of gain. As compared with this result, a ration of $6\frac{1}{2}$ pounds of cottonseed meal and 25 pounds of cottonseed hulls gave a daily average gain of 1.85 pounds at a cost of 12 cents; one of 10.5 pounds of corn, 3.75 pounds of cottonseed meal, and 13.5 pounds of crab-grass hay, an average daily gain of 2.68 pounds at a cost of 9 cents; and one of 6 pounds of corn, 5 pounds of cottonseed meal, 20 pounds of sorghum silage, and 14 pounds of cottonseed hulls, an average daily gain of 2.68 pounds at a cost of 10.6 cents per pound of gain.

In the experiments on milk production, milk produced on cottonseed meal as a protein feed costs 17 cents per gallon, and on coconut meal 18 cents. With sorghum silage as a source of carbohydrates the milk cost 19 cents per gallon, and with sweet potatoes 22 cents. Two tests were made with cottonseed meal and velvet beans in the pod. In the first test, when feeding velvet beans, the cost per gallon of milk was 16.7 cents, and when feeding the cottonseed-meal ration 18 cents. In the second test the velvet-bean ration produced milk at a cost of 17 cents per gallon, and the cottonseed meal ration at 20.5 cents per gallon.

In cattle-breeding experiments 5 native cows were bred to a Hereford bull, 5 to a Shorthorn, and 5 to a native Florida bull. Two calves from each bull were kept until from 2 to 3 years old for comparison. The average birth weight of the calves from the different bulls was as follows: Shorthorn, 56; Hereford, 47.9; and native, 48.6 pounds. At 1 year of age the calves from the Shorthorn bull averaged 447.5; from the Hereford, 405 pounds; and from the native, 447.5.

The results obtained with Japanese cane have shown this plant to be one of the best forage crops for the State. Yields of from 18 to 27 tons per acre were secured at a cost of approximately \$15 per acre.

The station carried on cooperative work with citrus growers, especially in stem-end-rot investigations, and in treating the white fly with fungus. In this work the station acted in an advisory capacity. Extensive work was carried on in connection with the Bureau of Plant Industry of this department, especially in testing new forage-crop introductions.

Extensive plans were inaugurated by the university for carrying on extension work, which was placed directly in charge of the director of the station. The farmers' institute work was made a part of the extension work. The State appropriated \$15,000 for extension work during the biennium.

The publications received from the station during the year were as follows: Bulletin 99, Milk Production; 100, Corn; 101, Pineapple Culture—VI, The Effect of Fertilizers upon the Quality of the Fruit; 102, The Velvet Bean; and the Annual Report for 1909.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
Fees	85.00
Farm products.....	1,058.79
Total	29,143.79

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Florida station is well managed and its work is energetically and systematically prosecuted. Its business is entirely separate from that of the agricultural college. The new equipment is gratifying evidence that the work of the station is much appreciated.

GEORGIA.

Georgia Experiment Station, *Experiment*.¹

Department of Georgia State College of Agriculture and Mechanic Arts.

M. V. CALVIN, *Director*.

At the Georgia station no changes in the lines of work occurred during the year. L. J. Herring, appointed animal pathologist and veterinarian, entered upon his duties January 1, 1910. After the close of the fiscal year, P. N. Flint, animal husbandman, left the station to take up similar work at the Arkansas station, and H. P. Lykes was appointed in his place.

Some progress was made in nearly all of the Adams-fund projects undertaken by the station. The Texas-fever project was followed up by the veterinarian during the season, but owing to a scarcity of material little work was done on the problem of white scours in calves. In connection with the study of Muscadine grapes 1,000 seedlings were planted and 200 crosses were made. Considerable work was done by the horticulturist in cooperation with the bacteriologist on Japanese plum wilt and tomato rot, and tests were made of the use of sprays and fertilizers as a means of controlling them. Work on the tomato rot was carried on during the winter in the greenhouse, and a bacteriological study was made with a view to determining the causative agent of the disease.

The investigation of the influence of manures upon the bacterial flora of the soil was continued, and work on the cotton red spider was also carried forward. Experiments were made with reference to the maintenance ration, and especially the protein requirements of calves. For this work 23 calves were used, and in addition to the nutrition study digestion experiments were conducted in which the chemist cooperated. In the cotton-breeding work a number of hybrids were planted and their character studied. Observations were made on a large number of varieties of cotton with regard to their resistance to anthracnose, and inoculation experiments were carried on, together with laboratory work, on the effect of disease on the plant. The study of nitrogenous compounds of the cotton plant has resulted in an accumulation of data about to be published. Investigations on the potash and phosphoric-acid compounds were taken up during the year.

¹ Telegraph, freight, and express address, *Griffin*.

Under the Hatch fund the horticulturist conducted variety tests and fertilizer experiments with cabbage, with special reference to securing fresh cabbage in winter. Experiments were also conducted with watermelons, figs, sweet potatoes, celery, peaches, and pecans. The effect of clean culture in orchards was compared with sod and no cultivation, and an effort was made to determine the possible influence of the reduction of vigor in apple trees on the prevalence of blight. Spraying experiments were made with lime sulphur and Bordeaux mixture on grapes and with different solutions on peaches. Work was also done on the control of the twig girdler and on methods of blanching celery.

In animal husbandry experiments were made with sorghum and corn meal as a source of carbohydrates for dairy cattle, and Spanish peanuts, soy beans, and skim milk were compared as supplements to corn in pig feeding. The best returns were from feeding corn and peanuts. Hog breeding was begun by crossing the razorback with the Berkshire, with a view to grading up the stock.

The agronomist conducted the customary fertilizer and field tests with corn and cotton, and continued the tests of varieties of cotton. In addition fertilizer experiments were made with tankage, cottonseed meal, nitrate of soda, and nitrate of ammonia as sources of nitrogen, the largest yield being with sulphate of ammonia. Other experiments in agronomy included a variety test of oats, a comparison of sumac sorghum with Link hybrid, the growth of vetch and rye and crimson clover as cover crops, and a comparison of 30 varieties of soy beans tested in cooperation with this department.

The following publications were received from the station during the year: Bulletins 84, pt. 1, Corn Culture; 85, Some Studies on *Colletotrichum gossypii*; 86, Sorghum v. Corn Meal as a Source of Carbohydrates for Dairy Cattle; 87, Spanish Peanuts, Soy Beans, and Skim Milk as Feeds Supplementary to Corn; 88, Corn Culture; and 89, Cotton Culture.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation.....	710.10
Farm products.....	5,760.51
Balance from previous year.....	1,830.17
Total.....	36,300.78

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

At the Georgia station there was general improvement during the year and lines of work of interest to the agriculture of the State were followed.

GUAM.

Guam Agricultural Experiment Station.

Under the supervision of A. C. TRUE, Director, Office of Experiment Stations,
United States Department of Agriculture.

JOHN B. THOMPSON, B. S., *Special Agent in Charge.*

The Guam station now owns the property on which it is located, the sale having been completed during the past year. The land has been cleared of its tropical growth, fenced, roads constructed, and some necessary buildings erected. Of the 32 acres adapted to general agriculture all but 5 or 6 are now under cultivation. A water supply for the station has been secured by the digging of a well, the construction of a reservoir, and the installation of an engine, pump, and pipes.

The greater portion of the available land has been planted to forage crops of various kinds, and comparisons are being made of Kafir corn, Egyptian corn, broom corn, sorghum, milo maize, Johnson grass, Guinea grass, *Paspalum dilatatum*, peanuts, mung beans, jack beans, cowpeas, soy beans, and velvet beans. Kafir corn has produced large yields of green feed, and when cut the plants send out new shoots, quickly producing a second crop. This ratooning habit has been found to apply to a number of crops in Guam that are ordinarily grown as annuals. The experiments with leguminous plants are proving quite successful, so far as the growing of the plants and the amount of forage produced are concerned. A variety of bush Lima beans has been secured which produces a large amount of forage and at the same time is more easily plowed under than cowpeas or velvet beans.

Some attention is being given to corn culture and methods for improving it, and the special agent has introduced a small hand mill for grinding corn to take the place of the usual laborious method. Experiments were conducted to determine practicable methods for storing corn and other grains, and it was found that by kiln-drying and sealing the grain in tanks it could be preserved against loss for future use.

The introduction of fruits and vegetables will be made an important part of the work of the station. A number of varieties introduced through the Hawaii Experiment Station have proved superior to anything previously grown in Guam.

The income of the station during the past fiscal year was as follows:

United States appropriation-----	\$15,000.00
Sales and other funds-----	23.41
Total-----	15,023.41

The work of this station has progressed exceedingly well, considering the limitations under which it has been carried on. Its supplies to a large extent must be obtained from San Francisco, and the special agent has had but one skilled assistant during the time when much of the pioneer work was in progress. The people of Guam appear interested in the work and are readily adopting new crops and methods when their superiority is shown.

HAWAII.

Hawaii Agricultural Experiment Station, Honolulu.

Under the supervision of A. C. TRUE, Director, Office of Experiment Stations,
United States Department of Agriculture.

E. V. WILCOX, Ph. D., *Special Agent in Charge.*

A new office and library building was erected during the past year from funds supplied by the Territory of Hawaii. This building gives better library facilities than the old one, and in addition contains offices for the special agent in charge, clerical force, entomologist, and agronomist. The concrete building formerly used as office building and chemical laboratory has been remodeled and is now wholly occupied as laboratories for the chemist and horticulturist.

By an Executive order of March 25, 1910, the land on which the principal buildings are situated was transferred from the Navy Department to the Department of Agriculture, and the cultivated area was extended by the clearing of about 10 acres at an elevation of approximately 250 feet. Most of this new area has been planted to tropical orchard crops of various kinds.

The principal lines of work are conducted with a view to diversifying the agriculture of the Hawaiian Islands. The agronomist has continued his work with cotton, experiments being carried on principally with Sea Island and Caravonica types, which are planted as perennials. The results thus far obtained have been so successful that more than 500 acres were planted during the past year for the commercial production of fiber. The experiments with this crop include pruning, propagating, fertilizing, and cultivation. The work begun some years ago with rice has been extended, the agronomist visiting Japan for the purpose of studying the rice industry in that country, and also for the introduction of varieties of Japanese rice. Some of the types introduced have appeared adapted to Hawaiian cultivation, and the grain is better suited to the demands of the Japanese population. The fertilizer experiments with rice, which have been carried on in cooperation with the chemist, have demonstrated that the fertilizers should be applied before planting and not with the irrigation water during the growth of the plant, as is the usual practice. It has also been found that ammonium sulphate is a better

source of nitrogen for rice in Hawaii than sodium nitrate. In addition to the crops mentioned above, some attention is given to corn breeding and the value of leguminous plants when grown for cover crops and for forage.

The station chemist has continued his pineapple investigations, giving particular attention to the effect of manganese on the plant, the process of ripening of the fruit, and the utilization of the by-products from the canneries. It appears probable that where manganese in considerable quantity is present in the soil the cultivation of pineapples should be discontinued, but investigations are still in progress to ascertain whether the application of fertilizers might not overcome the injurious effect of the manganese. In connection with these investigations it has been found that one of the most serious drawbacks to pineapple cultivation is a lack of aeration in the soil, and this subject is being given especial attention.

The horticulturist has perfected methods for the propagation of the mango and avocado, and is continuing his efforts in building up collections of desirable varieties of tropical fruits.

The entomologist has given especial attention during the past year to insects attacking sweet potatoes, and attempts are being made to introduce parasites of the weevil that has proved so destructive to the algaroba bean.

The station is carrying on cooperative experiments with a number of crops in different parts of the island, and has begun the establishment of demonstration farms, the funds for which are supplied by the Territory.

The publications of the Hawaii station during the past year were the Annual Report for 1909; Bulletins 19, Experiments in Tapping Ceara Rubber Trees; 20, Shield Budding the Mango; 21, A Study of the Composition of the Rice Plant; Press Bulletins 25, Carbon Bisulphid for Killing Weeds; 26, The Algaroba in Hawaii; and 27, The Use of Insecticides in Hawaii.

The revenues of the station for the fiscal year ended June 30, 1910, were as follows:

United States appropriation	\$28, 000. 00
Sales and other funds.....	389. 29
Territorial appropriation.....	7, 500. 00
Individuals	393. 50
Total	36, 282. 79

The work of the Hawaii station for the diversification of agriculture is making steady progress. The aid that it has given in studying various problems has resulted in the establishment of cotton planting as a commercial enterprise, as well as an extension of a number of minor industries. The appreciation of the work is readily seen by the increased interest and support given the station by the people of the islands.

Hawaiian Sugar Planters' Experiment Station, Honolulu.

C. F. ECKART, M. S., *Director of Division of Agriculture and Chemistry.*

The most important entomological work of the year was the continuation of the attempt to introduce and establish the parasitic fly which destroys the grubs of the cane borer throughout the Moluccas, New Guinea, and other regions infested with this pest. The parasite was actually introduced, and its breeding freely in captivity in Hawaiian borers has given promise of its establishment. Work in the introduction of the horn-fly parasite, *Bathymetis*, was also continued, but this insect has been found difficult to rear in confinement. Reports were prepared on certain sugar-cane pests, the Angoumois grain moth, the corn leaf-hopper, and the cotton-boll *Gelechia*, and studies made of the cane leaf-roller and various flies as spreaders of disease, especially typhoid fever.

In the pathological work 22 distinct fungi were isolated from diseased canes and grown in pure cultures. This work also included similar studies of the diseases of pineapples, with which 9 distinct fungi were found to be associated. Results of observations seem to indicate that the fungus *Thielaviopsis* is responsible for all the more serious diseases of pineapple plants, being apparently the direct cause of the soft rot of the fruit, base rot of cuttings, and the decay of many roots. It was demonstrated that even in its most resistant forms this fungus is killed within a few hours by exposure to direct rays of the sun. Attention was also given to diseases of leguminous plants and to the cane disease known as *iliau*. It was found that *iliau* is caused by a parasite fungus, a new and undescribed species of *Melanconium*. A study was also made of a serious cane disease prevailing in the Fiji Islands. A considerable amount of inspection work was also performed.

The forestry work of the station included experimental planting of tree seeds on a small scale at Kailua, Maui. Arrangements have been made to obtain seeds for this work from British East Africa, Mauritius, the Philippines, West Indies, and the southern United States.

The department of chemistry and sugar technology made a total of 3,107 analyses during the year and published the results from research investigations in six different bulletins. The different problems studied in this connection were the influence of the structure of cane on mill work in sugar factories, the determination of sucrose in molasses, the composition of bagasse with special reference to sugar and moisture, sulphate scales in evaporators and their prevention, biochemical processes in Hawaiian soils, and the inversion of cane sugar under the influence of acids and neutral salts. A series of lysimeter experiments were started with two different types of soil

for the purpose of studying the action of different forms of lime on nitrification and the effect of different fertilizing elements, alone and in combination, on the nitrogen in the soil and that supplied in the fertilizer application.

The usual control tests were made at a number of mills during the grinding season and detailed reports were submitted to the parties interested. During the year ending September 30, 1910, 43 compiled statements of weekly mill reports were issued by the station.

The results secured at the plantation substations brought out the distinct merits of Demerara seedling 1135. This cane gave remarkably good results at all the substations, at three of which it surpassed in yields the best of 20 plats of the standard cane and Lahaina and Yellow Caledonia grown for comparison. A number of plantation substations were started or projected during the year. In an experiment conducted for the purpose of securing suitable leguminous crops for green manuring in the various districts of the islands, 110 varieties were planted in the station fields during the year, and of these 26 gave promise of warranting their further trial on a larger scale. The genera which appeared to furnish the best varieties for this purpose were *Stizolobium*, *Dolichos*, *Canavallia*, and *Vigna*.

The following publications of the station not noted in last year's report were received during the year: Division of agriculture and chemistry, Bulletin 30, The Influence of the Structure of Cane on Mill Work in Sugar Factories; division of pathology and physiology, Bulletin 6, Fungus Maladies of the Sugar Cane; division of entomology, Bulletins 6, The Hawaiian Sugar Cane Moth (*Ereunetis flavistriata*), with An Account of some Allied Species and Natural Enemies; 7, Army Worms and Cutworms on Sugar Cane in the Hawaiian Islands; and 8, A Bibliography of Sugar-Cane Entomology.

This station receives no direct aid from the Federal appropriations.

W. J. Hartung was appointed an assistant chemist to succeed F. T. Dillingham and F. Evans was appointed agriculturist to replace E. G. Clarke. R. C. L. Perkins, director of the division of entomology, returned from a year's leave of absence in May. A plant house, 17 by 25 feet, with screen sides and glass roof, was erected for the isolation of plants in infection experiments by the division of plant pathology.

IDAHO.

Agricultural Experiment Station of the University of Idaho, Moscow.

Department of the University of Idaho.

W. L. CARLYLE, M. S., *Director*.

As an outgrowth of the administrative difficulties which occurred the year before, the Idaho station was under the direction of an acting director during the first half of the year, Director W. L.

Carlyle not entering upon his duties until January, 1910. Otherwise there were no changes in the station staff during the year, but with reference to the supervision of the substations some rearrangement was made. There was no increase in the State appropriations over previous years, and the building operations were limited to the erection of a section of the greenhouse. The station engaged in several new lines of work in addition to those already in progress.

Work on the Adams-fund project, including several new lines of investigation, was actively pursued. In connection with the apple-breeding project, which was enlarged in scope, over 5,000 pollinations were made, of which about 50 per cent were successful. The mutual affinities of varieties were taken into consideration for the purpose of gaining a better understanding of the principles involved, and incidentally of determining how varieties should be mixed in planting orchards to obtain best results in pollination and the setting of fruit. About 80 apple hybrids were under observation.

The studies of the duty of water in irrigation which were transferred from Caldwell to Gooding were carried on in cooperation with the irrigation investigations of this office. Different measured amounts of water were used in the culture of oats, wheat, barley, milo maize, sorghums, grasses, corn, and some other forage crops, and soil-moisture studies were made and data collected on the proportion of grain to straw and other parts, fruiting periods, and other phases of growth and production. The evaporation of water from a free surface was studied by means of an evaporation tank, and the determinations of soil moisture were made in a small laboratory fitted up for the purpose. Some of the results of this work, although as yet incomplete, indicate that in many instances far more water is used in irrigating crops than is desirable for best results.

At Caldwell, the effect of different methods of cultivation on evaporation in comparison with a free water surface was studied by means of eight water-jacketed soil tanks. These tanks were irrigated with as much water as the soil would take up and then given different treatment as to depth of cultivation for a period of eight weeks and the air temperature and the soil temperatures to different depths were determined. The effect of subsoiling on the absorption and retention of soil water was studied on an acre of alfalfa which was subsoiled three years ago to a depth of 3 feet. No difference has as yet been observed between the subsoiled land and the check plot.

In the work on the gluten content of wheat with reference to cause of deterioration and methods of improvement, the effect of irrigation and of row culture versus field culture was studied at Gooding, and samples of wheat from different parts of the State were milled to ascertain where wheat highest in gluten is produced. The samples coming from the southern part of the State were found to be highest

in gluten, and wheat rotated with potatoes, clover, and peas was found richer in protein than wheat grown continuously with summer fallow. Three strains of Turkey red wheat, two of them coming from Kansas and Nebraska, were grown. The first year these strains held up but the next year, which was very wet, they declined in quality. Wheat from Minnesota was also grown and the effect of cultivation tested. A record was kept of the moisture in the plats, and nitrate and nitrite determinations are to be made. The project includes a study of the milling qualities of wheat and the flour from the milling tests was analyzed and baking tests were made. The effect of adding sugar to the flour was studied, and also the effect of the amount of sugar in the flour on the size of the loaf. Sugar improved the baking quality of flour from wheat grown in the northern part of the State, but it did not have this effect on flour from wheat produced in the southern part. A study of the relation of calcium and magnesium in the growth of wheat was also taken up.

In the new project on the keeping quality of butter as affected by different factors in their relation to bacteria and other organisms carried on jointly by the dairy and bacteriological departments, about 10 experiments were made representing 350 pounds of butter in 10 tubs, paraffined and placed in cold storage at from 10 to 14° F. The factors studied are pasteurization, salting of butter, and the ripening of cream to different degrees of acidity. At the end of 189 days of storage it was found that some of the butter was deteriorating, and that the bacteria had all disappeared and molds and yeasts were the only organisms present. About 150 species of bacteria were isolated and identified. Chemical analyses of the samples were made and the butter was sampled and scored by experts every month.

Under the Hatch fund the agronomist conducted ear tests of corn to obtain material for breeding, work with soy beans and also with field beans to take the place of summer fallow, and tested varieties of wheat, barley, and field peas. Soil samples were taken in the plats and moisture tests were made. At Gooding, trials with seedling alfalfa with different amounts of seed and cultural tests with a number of forage plants were conducted.

In animal husbandry, feeding experiments were made with hogs to test the value of soy-bean meal brought from Manchuria and Japan, and of tankage obtained as a by-product from the Portland slaughterhouses. In steer-feeding experiments, wheat, barley, and corn were compared, and while there was not much difference, corn gave the best results, followed by wheat and then barley.

The horticulturist carried on variety tests with strawberries, commercial experiments with muskmelons and tomatoes to determine the best methods of marketing, and a culture experiment with onions.

Training and pruning experiments with orchard fruits were also in progress.

The chemist made chemical and mechanical analyses of soils from different parts of the State, selecting soils from localities where different types exist. A study was also carried on at Boise on the composition of fruit grown under irrigation. The results of several years of study on the same varieties of fruit grown in northern Idaho without irrigation are on hand. In this work attention was given to the causes affecting the quality of fruit, particularly the soil as it influences the ash and sugar content.

In dairying, observations were made on the shrinkage of butter in pound lumps and in 90-pound cubes when kept in storage. The station cold-storage plant can be held at about freezing with the refrigerator system. The creamery is run the year round as a separate establishment from the station.

Little cooperative work other than that already mentioned is followed. The station officers took part quite extensively during the year in work at farmers' institutes and movable schools. The appointment of three field men for extension work in horticulture and entomology, irrigation and general farming, and dairying, respectively, was authorized to relieve the staff from this class of work.

The following publications were received from this station during the year: Bulletins 66, Alfalfa; 67, Better Dairy Methods; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
Farm products, including balance from previous year..	4,355.17
Total.....	32,355.17

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Idaho station is recovering from the effects of the disruption of last year, and under the present régime is strengthening its organization, extending its lines of work, and improving its prospects in general.

ILLINOIS.

Agricultural Experiment Station of the University of Illinois, *Urbana*.

Department of the University of Illinois.

EUGENE DAVENPORT, M. Agr., *Director*.

Few changes were made in organization, personnel, or lines of work during the year. The changes made on the station staff were as follows: J. L. Edmonds succeeded R. C. Obrecht as associate in

horse husbandry, and R. B. Howe and I. S. Brooks, assistants in pomology; C. H. Myers, assistant chemist; D. L. James, assistant in dairy husbandry; and L. Hegnauer, assistant in crop production, resigned during the year. After the close of the fiscal year, H. P. Rusk, formerly of the Indiana station, was made assistant in animal husbandry. The only increase in the funds of the station in addition to the increase in the Adams fund was for soil investigation, and this amount was used largely to extend the work of the soil survey.

Five of the station's projects were maintained in part by the Adams fund. Three of the projects deal with problems in breeding plants and animals. The experiments on inbreeding of pigs and corn have given evidence that long-continued inbreeding of corn is followed by the appearance of strains that flourish comparatively well under close breeding. The purpose of the work in inbreeding of pigs is not to study the results of the investigation upon general averages alone, but also to secure individuals which may not suffer under inbreeding. A large amount of data has accumulated in the various inbreeding investigations. Especial attention was given to the proper methods of analyzing the data, and the likelihood of the appearance of false correlation in the study of the heredity problem was established.

The transmission of characters in apples, sweet peas, strawberries, and *Rubus* was also studied. Special attention was given to the behavior of color transmission in sweet peas, and some significant although not yet quite conclusive data bearing upon this point were secured.

The chemical study of the composition of various spray materials was continued, particularly Bordeaux and lime-sulphur mixtures prepared in different ways, and of their effect on foliage under various conditions. The results up to date show no evidence indicating danger to orchard trees from the accumulation of copper sulphate in the soil as a result of spraying. The trouble known as yellowing of leaves did not appear to have any relation to weather conditions and to the use of Bordeaux mixture. It was shown that copper sulphate solutions cause yellowing when of sufficient strength. These solutions, varying from 1:100 to 1:1,000, when absorbed by trees through wounds invariably killed the leaves on the particular part affected and caused them to turn brown. In one case absorption of a solution 1:25,000 was followed by yellowing of the leaves.

A large amount of analytical data has also accumulated in the investigations on the digestion and utilization of feed in maintenance, growth, and fattening, carried on with steers, swine, and sheep.

A large amount and variety of work was also performed under the Hatch and other funds in addition to the Adams-fund projects.

The comprehensive work of the station on the soil survey of the State, soil fertility, and improvement of soils was continued and extended, and a more certain knowledge of the comparative character of lands in different parts of the State, as based on the results of this work, was gained. A comparison of drilling and broadcasting oats, carried on for three years at two places and two years at another showed a net gain in favor of drilling.

Feeding experiments were made with horses, cattle, sheep, and hogs. In a comparison of methods of feeding short-fed steers, the use of chopped hay mixed with the grain and fed through a self-feeder gave more rapid gains and at slightly less cost per pound than when the same feeds were fed separately twice per day. In studying the relative efficiency of different rations for fattening horses for marketing, a mixed grain ration of corn and oats when fed with clover hay was more efficient than a single grain ration of corn, and although more expensive than corn and clover hay the gains made its use more economical. Clover hay fed with a mixed-grain ration of corn and oats produced 58 per cent more gain than timothy hay. A nutritive ratio of 1:10 was found too wide for best results, which were secured with a nutritive ratio of 1:8.

Investigations were made on the viability of the bovine tuberculosis organism, and work on contagious abortion was continued. A study of the composition of butter disclosed no difference in composition due to the season of the year or the locality of manufacture, and the variation in composition of samples taken from the various creameries was not greater than in the samples taken from any single creamery. The pasteurization of the cream gathered from farms was found, as a rule, to have improved the keeping quality of the butter to some extent, and did not affect the body or texture of the butter, but the curdling of cream as a result of the treatment increased the loss of fat in buttermilk. Observations made on the economy of the round dairy barn show that this type of structure offers greater convenience in storing, handling, and distributing feed, and gives much greater strength to the building with less lumber. It is stated that material for rectangular barns costs from 34 to 50 per cent more than for round barns of the same capacity.

Along horticultural and botanical lines, studies were made of molds or ear rots of corn, apple canker, and spotting of maple leaves, and considerable cooperative work was carried on with spraying, drainage, and with fertilizers for fruits and vegetables. Experiments were also made with melons, tomatoes, onions, and lettuce and with fertilizers for carnations. It was shown that for the production of early tomatoes on the particular field where the tests were made a mixture of steamed bone, dried blood, and potassium sulphate was superior to other fertilizers used and that the leaf spot of tomato

can be controlled by spraying with Bordeaux mixture. Attempts to ward off early frosts by use of the smudge pot in the orchard pointed out the greater difficulty of employing this method in open country than in inclosed valleys and mountain pockets.

The demonstration work of the university and station continued to increase during the year. Eleven additional demonstration farms were secured, making the number of such farms now in operation about 36. These farms contain about 20 acres and are used for the demonstration of methods of farm management and permanent soil improvement. Two additional tracts for horticultural purposes, one a 20-acre orchard and the other a 76-acre farm near Olney, were acquired. At a number of these points in the State individuals have clubbed together and secured pieces of land which they have deeded to the university for the purpose of soil or crop experiment fields. In a number of instances the university assisted local enterprise in planning and executing schemes for the maintenance of community demonstration fields, generally in connection with a school.

The following publications were received from this station during the year: Bulletins 135, Bordeaux Mixture; 136, Methods of Seeding Oats, Drilling and Broadcasting; 137, A Study of Factors Influencing the Composition of Butter; 138, Pasteurization as a Factor in Making Butter from Cream Skimmed on the Farm; 139, Composition of Market Butter; 140, Dairy Suggestions from European Conditions as Seen in the British Isles, Holland, and Denmark; 141, Relative Efficiency of Different Rations for Fleshing Horses for Market; 142, Short Fed Steers: A Comparison of Methods of Feeding; 143, Economy of the Round Dairy Barn; 144, Growing Tomatoes for Early Market; Circulars 122 (rev.), Eight Years' Soil Investigation in Southern Illinois; 131, Handling of Cream and Making of Butter on the Farm; 132, A Portable Panel Fence; 133, Feeding the Pig; 134, Cow Index of Keep and Profit; 135, How to Fix up the Yard: Some Kinds of Trees, Shrubs, and Vines, and Where to Plant Them; 136, Directions for Making Spray Mixtures; 137, Results of Spraying Experiments, 1909; 138, The Small Home Yard; 139, How to Grow Muskmelons; 140, The Live Stock Situation in Illinois; 141, Crop Rotation for Illinois Soils; 142, European Practice and American Theory Concerning Soil Fertility; and 143, Conservation of Energy, and its Relation to the Dairyman.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation	138,000.00
Farm products.....	14,546.81
Balance from previous year.....	21,393.11
Total	201,939.92

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Illinois station is conducting a large amount of scientific and practical work, organized on an extensive scale in many departments. The Federal funds are liberally supplemented with State funds, and the work of the station now covers the State in a quite comprehensive way.

INDIANA

Agricultural Experiment Station of Indiana, *Lafayette*.

Department of Purdue University.

ARTHUR GOSS, M. S., A. C., *Director*.

The year was one of great activity at this station in developing the work on soil and crop improvement, dairying, poultry raising, animal husbandry, hog cholera and other animal diseases, and horticulture, for which largely increased appropriations were made by the last legislature. The terms of the law which makes these appropriations, aggregating \$75,000 annually, are very broad, namely, "to aid in acquiring and disseminating among the people of the State useful and practical information on subjects relating to agriculture and to promote investigations concerning the principles of agricultural science," and "for the purpose of providing the necessary equipment and paying the expenses of conducting experiments and investigations and otherwise acquiring information and disseminating said information by means of publications, lectures, and otherwise."

The act provides that the investigations shall be carried out along lines agreed upon by the director of the station and an advisory committee of five persons representing (1) the State Corn Growers' Association, (2) the State Dairymen's Association, (3) the State Live Stock Association, (4) the State Horticultural Society, and (5) the State Poultry Fanciers' Association. The appropriation is continuous and provides for general maintenance of the station and for extension work as well as for the special lines of investigation named.

The station acquired about 32 acres of additional land for horticultural and poultry experiments, and considerable plantings of apples and small fruits were made upon a portion of this area. A new greenhouse for the use of the botanist and a seed and fertilizer house for the agronomist were completed during the year. An area of about 5 acres better suited for the work on hog cholera and other animal diseases was acquired for the veterinarian. The management of the dairy herd was transferred from the department of animal husbandry to that of dairying.

Increased provision was made for extension work by the station. The policy with reference to this work is to have in each main department of the station at least one man who ordinarily takes part in the regular work of the department under the direction of its head, but is subject to call from the head of the extension department of the college for work under his direction when needed. In accordance with this policy, several extension assistants were added to the station staff during the year and others are to be appointed.

Additions to the station staff during the year were made as follows: F. G. King, associate in animal husbandry; A. G. Philips, associate in poultry work; W. R. Wright, assistant dairy bacteriologist; J. W. Wellington, Morris W. Richards, and J. G. Boyle, assistants in horticulture; C. R. Orton and Mary A. Fitch, assistants in botany; Otis Crane, extension work in poultry; D. O. Thompson, extension work in animal husbandry; and Helen H. Henry, assistant in extension work. Since the close of the year H. P. Rusk, assistant in animal husbandry, resigned to accept a similar position in the Illinois station.

Little change was made during the year in the lines of work carried on with the Adams fund. The work on rusts was continued, and among other results it was found that there are two distinct species of rust on the clovers, one with red clover and the other with white clover as the principal host. In greenhouse work more than 300 collections of rust material were used and inoculations were attempted on more than 500 host plants.

The work on the factors influencing condensed milk was completed and standards for evaporated milk, sweetened condensed milk, and condensed skim milk were worked out. It was pointed out that the Federal standard of evaporated milk is too high and can be complied with only under the most favorable conditions, and a new standard for evaporated milk is recommended. The studies on moisture content of butter and conditions affecting it were partly completed, and important work was also done during the year on the keeping quality of butter made from raw and pasteurized cream. The results of some of these experiments show that the percentage of olein in butter fat is highest during the summer months and lowest during the winter months, that the glycerids of the soluble and oleic acids, having a low melting point, are capable of absorbing and retaining over twice as much water as the fats of high melting point, that the period of lactation and feed largely control the relative proportion of hard and soft fats, and that the moisture-retaining property of butter is largely governed by the percentage of soluble and oleic acids present.

A first report was issued on the hog-cholera investigations. This work during the year was confined largely to the production of hog-cholera serum and the improvement of the methods now employed in its production. Experiments were begun for the purpose of

increasing the amount of serum obtainable by injecting a normal salt solution into the abdominal cavities of a number of hogs used in the work. The injections were made two hours before the cholera hogs were bled, and as soon as the animals had died the virulent salt solution was removed. Eleven hyperimmunes were produced with this normal salt solution and all of them produced potent serum.

A large amount and variety of work was carried on during the year with Hatch and State funds. In agronomy the experiments with different systems of cropping and fertilization were continued, and experiments were further conducted in crop breeding, testing grain and forage crops, together with cultural methods, and in the use of cover crops following small grain. In the crop-breeding work most attention was given to the improvement of corn, wheat, and oats. Barley, cowpeas, soy beans, alfalfa, and timothy received some attention on a smaller scale. The results of continuous selection of seed corn from sucker-bearing stalks indicate that this practice is not injurious if the seed selections are made from otherwise vigorous stalks. In studying the effect of the shape of the seed ear upon the yield of corn the results of four years of continuous selection indicated that a moderately rough, medium size, rather cylindrical ear of Reid Yellow Dent, which was the variety under test, will give the best results. As the ear of this variety is normally a rather cylindrical type, a similar experiment was begun with Leaming corn, which has a rather tapering type of ear.

The value of alfalfa, cowpeas, and soy beans for Indiana has been demonstrated and the best cultural methods for these crops have been determined. Good results were secured from the use of cover crops after small grain. The green weight of the produce above ground on September 29 was found to be 10.8 tons of cowpeas and 9.3 tons of soy beans per acre. The cooperative work in this department in 1909 included 647 tests of 5 varieties of corn, 106 tests of 5 varieties of winter wheat, 53 tests of 3 varieties of oats, 81 tests of 4 varieties of soy beans, and 69 tests of 3 varieties of cowpeas.

In animal husbandry, records of feed and growth were kept on 12 stock farms. Feeding experiments, mainly with silage rations, were made with cattle, sheep, and hogs. Studies were made of the influence of age of animals, on gains, of nitrogenous supplements in cattle rations, short and long feeding periods, maintenance rations for brood sows, forage crops for hogs, and maintenance of fall and winter pigs. A report was made during the year on the use of dairy by-products as supplements to corn for fattening hogs. In connection with the poultry work a 16-acre tract of land was purchased, a poultry building, fencing and other necessary equipment erected, and experimental work on the value of high and low protein rations for laying hens was begun.

Investigations on eradication of weeds and on treatment of grain smuts in elevators were continued. Of six different chemicals used, common salt was found most convenient and effective for the eradication of Canada thistle. It is further found that, under certain conditions, white top in timothy meadows may be controlled by the use of chemical sprays, and that red sorrel and broad plantain are very greatly affected by sodium arsenite as a spray. Tests were made at the station and near Terre Haute of strains of the Stone tomato for canning purposes. Methods of spraying for canteloup rust were tested and a comparison was made of a single spray versus three sprays of arsenate of lead.

The horticultural department made plantings of catalpa and locusts for fence posts at the station and in different parts of the State. With funds provided by the State, 16 acres of land were purchased for this department, fenced, and partly set in fruit trees as an experimental orchard. An extensive experiment to test sod mulch as compared with clean culture was laid out. The search for valuable native seedling pecans has resulted in the finding of several more valuable varieties. A large amount of demonstration work in orchard improvement and management was carried on in different parts of the State.

The cooperative work of the station in testing varieties, methods of culture, and fertilizing is very extensive, over 1,000 farmers taking part in such work. The station gave particular attention during the year to the study of unproductive soils and the methods of improving them in about fifty different places in the State. Cooperation was also carried on with this department in seed examination and the study of grain insects. The extension work, which is now organized on a separate basis, included district farmers' short courses, fair exhibits, agricultural meetings and exhibits, horticultural demonstration meetings, and work in connection with an educational train, rural school of agriculture, and young people's contests. An educational train was run in the interests of the dairy industry and 2,558 persons heard the lectures given in this connection.

The following publications were received from this station during the year: Bulletins 136, Winter Steer Feeding; 137, Dairy By-products as Supplements to Corn for Fattening Hogs; 138, The San José Scale—Some Sprays for Its Control; 139, Results of Cooperative Tests of Varieties of Corn, Wheat, Oats, Soy Beans, and Cowpeas, 1909; 140, Hog Cholera; Circulars 16, Agricultural Extension; 17, The Farmers' Orchard; 18, Agricultural Extension.—II, Corn Shows and Selecting, Preparing, and Scoring Exhibits; 19, Agricultural Extension.—III, Industrial Contests for Boys and Girls; 20, Agricultural Extension.—IV, Milk Production, III, Economic and Sanitary Milk Production; 21, Agricultural Extension.—V, Spraying the

Orchard; and 22, Agricultural Extension.—VI, The Loose Smut of Oats and Stinking Smut of Wheat and Their Prevention; and the Annual Report for 1909.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation	75,000.00
Fees	22,837.21
Miscellaneous.....	41,933.40
Balance from previous year.....	11,477.77
Total	179,248.38

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

With the liberal appropriations available, the Indiana station is rapidly extending its work to cover effectively all phases of agriculture in the State, and is thus winning the cordial support of Indiana farmers.

IOWA.

Iowa Agricultural Experiment Station, Ames.

Department of Iowa State College of Agriculture and Mechanic Arts.

C. F. CURTISS, M. S. A., *Director*.

The work of the Iowa station was extended during the year mainly along lines previously pursued. The extension work of the institution was enlarged as a separate department. The new agricultural building, equipped, furnished, and occupied during the year, provides very complete and extensive equipment for instruction and experimental work in the different branches of agriculture. The station equipment in general was further improved by other important additions.

Many changes occurred in the station staff during the year. I. G. McBeth, of this department, who was appointed experimentalist in soil bacteriology, resigned after several months of service. J. H. Gordon was appointed assistant dairy bacteriologist and S. C. Guernsey assistant chemist. H. C. Pierce, poultryman, resigned to accept a position with this department in connection with market poultry investigations. J. H. Criswell accepted an appointment as agronomist at the Winona College of Agriculture in Indiana, and was succeeded in the farm crops department by H. D. Hughes, of the Missouri station, and H. B. Potter, of the South Dakota station. A. W. Dox, of the Connecticut Storrs station, was appointed station chemist, and J. M. Evvard, formerly of the Missouri station, was appointed experimentalist in animal husbandry.

In addition to the four Adams-fund projects already in progress at the station, studies were begun during the year on a project with reference to humus and its relations to the physiological activities of the apple. In the apple-breeding project, several thousand seedlings have been grown and crosses were attempted in the spring of 1910, but on account of untoward weather conditions did not meet with success. Progress was reported in the cattle breeding and feeding projects, as well as in the study of the relation of humus to crop production. The station has followed the policy of concentrating attention upon a few important lines of work under the Adams fund.

The activities of the station further included numerous lines of work conducted with other funds. The work in animal husbandry embraced experiments on the relative merits and profitableness of different methods of preparing corn for feeding hogs, and a bulletin publishing the data points out that the most satisfactory results were secured from feeding dry ear corn until the hogs weighed about 200 pounds. For hogs above 200 pounds soaked shelled corn gave the most economical gains of all the forms in which corn was fed. Experiments were also made to compare the value of corn, oil meal, cottonseed meal, and gluten feed in work-horse rations, the points receiving special attention being the health of the horses, degree of spirit maintained, ability to endure hard work and hot weather, maintenance of weight and flesh, and the economy of the ration.

A feeding test with fattening lambs, in progress for three years, was made for the purpose of comparing a ration of grain and hay with rations containing succulent feed, comparing sugar beets, mangels, turnips, rutabagas, cabbage, and corn silage as sources of succulence in this connection, and determining whether succulent feed is essential to rapid gains, high condition, and quality of finish. In collaboration with the department of chemistry, studies in progress for five years were continued on the influence of feeding sugar beets and mangels to breeding animals, with special reference to the formation of renal and urinary calculi.

A comparison of the value of stock foods for swine, also made by these departments cooperatively, showed that the foods in question had no beneficial effect on the digestion and that they did not appreciably affect the gains secured when these preparations were fed together with corn.

The dairy department conducted experiments on pasteurization and use of starters in butter making, investigated the causes of metallic flavors in butter and of losses in butter making, and gave attention to the problem of shrinkage in butter and to the preparation of ice cream and similar foods.

The horticultural department, among other lines of work, carried on experiments in spraying for fruit diseases, especially of grapes

and for blight of potatoes, made observations on the injury to apples by lime-sulphur wash and Bordeaux mixture, experimented in top-working apples, and tested varieties of potatoes, together with cultural methods. Varieties of plums generally grown in Iowa were studied, described, and classified; experiments in the cold storage of Iowa-grown apples were conducted, and the results of observations as to the storing quality of different varieties were reported. Extensive plantings have been made of orchard fruits, mainly apples, but also pears, plums, and grapes.

The entomological work of the year embraced investigations on the oyster-shell scale and the apple leaf-hopper, and experiments in spraying for the codling moth. In the study of the apple-leaf hopper, special attention was given to its life history, classification, destructiveness, distribution, feeding habits and food plants, control measures, and natural enemies.

The station veterinarian completed and reported the results of tests made during several years for the detection of tuberculosis in cattle, and, in cooperation with the department of animal husbandry, studied the influence of infected cattle on the hogs following them, and the effect of feeding infected milk to swine. Observations were also made and reported on tuberculous cattle held in quarantine.

The botanist of the station had charge of the enforcement of the State pure-seed law, and in connection therewith made studies of the weeds of the State, and the means of eradicating them. The results of experiments on the eradication of weeds by means of chemicals or herbicides were published, together with observations on the germinability of seeds as affected by being kept in compost. Attention was also given to experiments in cultural methods for destroying quack grass. Work on fungus diseases of plants was also carried on, and the results of observations on certain plant diseases prevalent in 1908 were published in bulletin form.

The publications of the station received during the year were as follows: Bulletins 104, Some Plant Diseases of 1908; 105, Notes on Eradication of Weeds, with Experiments Made in 1907 and 1908; 106, Preparation of Corn for Hogs; 107, Tuberculosis and its Detection; 108, Cold Storage for Iowa Apples; 109, The Value of Corn, Oil Meal, Cottonseed Meal, and Gluten Feed in Work Horse Rations; 110, Roots and Corn Silage for Fattening Lambs; 111, The Apple Leaf-hopper (with popular edition); 112, The Influence of Feeding Sugar Beets and Mangels to Breeding Animals, with Special Reference to the Formation of Renal and Urinary Calculi (with popular edition); 113, Influence of Condimental Stock Foods on the Digestibility of a Corn Ration Fed to Swine (with popular edition); and 114, Plum Varieties (with popular edition).

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation-----	40,000.00
Fees-----	15.00
Farm products-----	10,973.76
Miscellaneous-----	661.20
Balance from previous year-----	1,747.46
Total-----	81,397.42

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Iowa station continues to do a large amount of work of great practical benefit to the State. It is especially active in disseminating the results of its work in popular ways.

KANSAS.

Kansas Agricultural Experiment Station, Manhattan.

Department of Kansas State Agricultural College.

E. H. WEBSTER, M. S., *Director.*

During the year a milling department was organized, with L. A. Fitz, formerly of the Bureau of Plant Industry of this department, in charge. A State department of forestry with headquarters at Manhattan was established, and C. A. Scott, formerly of the Iowa State College, was placed in charge. A. M. Ten Eyck, formerly agronomist of the station, entered upon his duties as superintendent of the Fort Hays substation; and after the close of the fiscal year, W. M. Jardine, of the Bureau of Plant Industry of this department, was appointed agronomist to fill the vacancy. C. W. Nash, formerly of the Maryland station, was made assistant in agronomy, and Turner R. H. Wright, assistant in animal nutrition. W. E. Davis, D. H. Rose, R. W. Graff, and Miss Anna Monroe, were appointed assistants in botany, A. R. Nystrom assistant in dairying, and J. W. Calvin assistant in chemistry. L. M. Peairs, of the Maryland station, succeeded T. H. Scheffer as assistant entomologist, the latter resigning to accept a position in the Bureau of Biological Survey in this department. W. E. King and R. H. Wilson, bacteriologist and assistant bacteriologist, respectively, of the station, resigned to enter commercial work. F. S. Jacoby was appointed assistant in poultry work, with D. E. Schreiner as foreman of the poultry plant. A. G. Phillips, assistant in poultry husbandry, resigned to take charge of the new poultry division of the Indiana Experiment Station.

The operations of the station have been greatly extended with the aid of the State appropriation of \$30,000 for the biennium 1910-11. The veterinary building was completed and to a large extent equipped during the year. Dairy barns were remodeled and additions made to the poultry plant. New silos were also built and the station herds of live stock were enlarged.

A large amount of work was done during the year on a number of important Adams-fund projects, largely, however, in continuation of well-established lines of investigation. Many of these projects have now progressed to a point where they are yielding results of great scientific value and are indicating important new lines of work. The new projects to which attention was given during the year include investigations on the green bug and the influence of nutrition on the form of growing animals, the latter, however, being a continuation and extension of investigations pursued for a number of years by President Waters at the Missouri station.

The investigations on the green bug dealt especially with the behavior of this insect under varying conditions of temperature and moisture. A similar line of investigation was followed with the Hessian fly and plant lice injurious to wheat and corn. Ingenious pieces of special apparatus have been devised for the prosecution of these inquiries.

The investigations on cerebritis in horses were extended during the year to include observations on cornstalk disease, but no decided progress was reported. The bacteriological studies of hog cholera were confined largely to inquiries as to the possibility of using a horse serum vaccine. The supervision of the inoculation experiments was turned over to the veterinary department, which gave a large share of its attention during the year to the preparation and distribution of serum for the prevention of hog cholera according to the method proposed by the Bureau of Animal Industry of this department.

The wheat-breeding investigations were continued as heretofore on an extensive scale, the botanist cooperating with the chemist in a study of the relation between hardness of wheat and protein content. In connection with this work it was ascertained by a thorough investigation of two pure strains of wheat, the one hard, the other soft, that a correct average or mean crushing point accurately expressing in grams the degree of hardness of the particular races under investigation, was reached by taking the mean of the crushing points of 350 kernels. The mean crushing points for the two strains under investigation were 6,817 and 11,802 grams, respectively, for a total of 2,700 kernels each. The accordance of the results in these two cases indicates that the facts disclosed are probably general. A machine was designed for use in connection with this work, which, while accurate as to results, it is realized must be modified to

admit of greater rapidity of operation for practical commercial purposes.

Studies were made during the year of the effect of various chemicals, bran, and bran extract on the baking quality of wheat flour from different sources, and of the relative digestibility of alfalfa stacked green, stored as hay in sheds, and in the form of meal.

A large number of additional lines of work were carried on with other funds. These included the preparation and distribution of hog-cholera serum on an extensive scale; the fattening of cattle with rations of cottonseed meal, corn, and alfalfa; comparative tests of different types of hogs, and dry-lot feeding versus pasture for hogs; tests of rations of tankage, shorts, and alfalfa for hogs; crossbreeding of sheep; comparison of different kinds of roughage for sheep; incubation, mating, and feeding experiments with fowls; corn fodder as compared with silage for dairy cows; ozonization of stale cream; use of artificial starters in butter making; investigations on the acidity of fresh milk; a study of the kind and functions of bacteria in milk and the associated action of such bacteria; opsonic action and germicidal properties of milk; field observations on the Hessian fly, including a study of methods of control; investigations on methods of control of gophers and moles; extent of infestation and methods of control of the San José scale; observations and cooperative experiments on the control of the codling moth and curculio; experiments on maintenance of soil fertility; rotations; culture of wheat and corn; water requirements of different crops; chemical examination of typical Kansas soils; production and distribution of improved seed of cereal crops; methods of curing alfalfa; observations on varieties, hardiness, and methods of culture of fruits, vegetables, and forest trees; and experiments in summer pruning and protection of orchards from frost.

A preliminary report was made on the influence of depth of cultivation on soil bacteria and their activities. The results suggested that plowing from 8 to 10 inches deep tends to increase the number of soil bacteria in both sandy and silt soils, and also tends to increase bacterial activity, as more ammonia is produced, and apparently decreases denitrification by the reduction of nitrates and the liberation of free nitrogen. An increase in soil temperature increased bacterial activity, and an excess of moisture reduced the number of bacteria and was detrimental to bacterial activity. The maximum number of bacteria was found within the fifth and sixth inches of the soil. It was further observed that different species of bacteria were present in the soil at different times and in predominating numbers, and that bacterial life and activity seem to rise and fall with more or less regularity and to a certain extent independent of moisture and

temperature, which is considered as possibly due to the presence of bacterial by-products.

The investigations with reference to the corn-ear worm showed that in Kansas this pest has three full broods and one partial brood. The larvæ of the first three feed mainly upon the corn and the latter part of the third and all of the fourth brood feed upon various weeds and alfalfa. The work on chinch bugs pointed out that this pest winters extensively in the clump-forming grasses of the badly infested parts of the State, and that most of the bugs can be destroyed by running fire over these infested grasslands in such a way as to burn the clumps down close to the ground. The bugs not destroyed by the fire are thus exposed to the rigors of the winter.

The agronomist published the results of several years' work with the cowpea, in which the varieties Whippoorwill, Mount Olive, New Era, and Gray Goose proved best for hay, Whippoorwill for ensilage, and New Era as a catch crop after wheat. The best time for planting the crop in central Kansas was found to be June 23 when grown for seed and about one week earlier than this when grown for hay. When grown with corn for silage the combined crop planted about June 1 gave the best results. A report was also made on a test of varieties of oats and barley, the improvement of small grains by selection and breeding, and the distribution of improved seed grain. The four best producing varieties of oats were Red Texas, Kherson, Sixty-day, and Burt; and Tennessee winter barley yielded $15\frac{1}{2}$ bushels more grain per acre for 5 years than the best-producing variety of spring barley. Spring wheat was inferior in production to barley, oats, and emmer. Durum wheat yielded about 50 per cent more than the ordinary spring wheat. Winter wheat and winter rye produced more bushels and more pounds of grain per acre than any of the other grains.

At the Fort Hays substation an area of 1,820 acres was under cultivation during the year, 1,500 in native grass, 180 in timber, and 300 acres leased. The experimental work carried on there included wheat breeding, tests of varieties and methods of culture, effect of exchange of seed and soil, production of improved seeds for distribution, and tests of varieties and methods of seeding oats, barley durum wheat, and speltz for spring culture, and of rye, emmer, and barley for winter culture. Tests were also made of various other field crops and their culture, of trees for windbreaks and park improvement, and of vegetables and bush and orchard fruits. The experiments in dry-land farming carried on in cooperation with the Bureau of Plant Industry of this department were continued during the year on the same lines as in previous years.

The cooperative work of the station with farmers of the State was mainly confined to the eradication of insect pests. The station also

cooperated with this department in plant-breeding work, but nothing very extensive was entered upon during the year. A large amount of extension work was undertaken in different parts of the State with a view to getting the farmers to follow some definite method of culture or some program in their feeding operations. In this work the farmers record such data as can best be kept and report the same to the extension department of the institution.

The extension department of the college was greatly enlarged during the year with the increased funds available for this purpose, and movable schools on different subjects were organized. E. L. Holton, of the Teachers' College of Columbia University, was added to the extension department during the year, for the purpose of introducing industrial training into the public-school system of the State.

The publications received from this station during the year were as follows: Bulletins 158, Analyses of Registered Feeding Stuffs; 159, Analyses of Eggs; 160, Cowpeas; 161, The Influence of Depth of Cultivation upon Soil Bacteria and Their Activities; 162, The Marketing of Eggs; 163, Hog Cholera and Vaccination; 164, The Selection and Feeding of Laying Hens; 165, Report of State Forester upon Forest Conditions in Central and Western Kansas; 166, Spring Grains; 167, A Quantitative Method for the Determinations of Hardness in Wheat; Circulars 2, Preparing Land for Winter Wheat; 3, Improved Seed Wheat; 4, Prairie-dog Situation; 5, Chinch Bug; 6, Variety Tests; 7, Corn-ear Worm; 8, Investigation of the Vitality of Kansas Seed Corn; Feeding Stuffs Bulletins 1-9, Registered Feeding Stuffs; and the Annual Report for 1908.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	13, 000. 00
State appropriations, including those for substations....	37, 400. 00
Fees	7, 499. 53
Farm products	7, 152. 02
Miscellaneous.....	11, 258. 54
Total.....	91, 310. 09

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The continued improvement in the organization of the Kansas station, together with the assistance the State is now giving the institution, is resulting in a broader sphere of action and in a greater efficiency in its various lines of endeavor.

KENTUCKY.

Kentucky Agricultural Experiment Station, Lexington.

Department of the State University.

M. A. SCOVELL, M. S., Ph. D., *Director*.

During the year the agricultural college of the State University was organized, with the director of the station as director of the college of agriculture. Few changes in personnel were made. T. R. Bryant, formerly assistant in animal husbandry, has been placed in charge of the extension department of the college. George Roberts, formerly chemist in the fertilizer division and agronomist, was made head of the division of agronomy of the station. B. D. Wilson was appointed assistant chemist, fertilizer division, vice William Rodes, resigned. D. J. Healy was appointed bacteriologist and microscopist with the beginning of the fiscal year 1910-11.

A very complete laboratory was fitted out for the bacteriological and microscopical work of the food and drug division of the station and for other bacteriological work, especially that connected with the study of milk fever under the Adams fund.

Progress was made in laying out for experimental purposes the \$7,000 addition to the station farm. With a State appropriation of \$2,000 the construction of a plant for the manufacture of hog-cholera serum was begun.

Arrangements were made for cooperative work, especially in dairying, on a large stock farm near Lexington. In this way observations and experiments can be made on a large number of selected animals under favorable conditions.

In the Adams-fund projects, considerable progress was made during the year in defining the differences in the root nodule organisms on different species and groups of leguminous plants. In this connection a study of the morphology and relationships of bacterial organisms producing nodules on the roots of alfalfa, sweet clover, red clover, white clover, soy beans, and cowpeas was made. The additional data secured seemed to give further proof that the organism of alfalfa is identical with that of sweet clover and is transferable from either plant to the other but not to red clover, white clover, soy bean, or cowpea; and that the organisms of red clover, white clover, and alsike clover are identical and can be transferred from any one of these species to any one of the other two, but can not be transferred to cowpea or soy bean. The organisms of the soy bean and the cowpea appear distinct. The number of broods of the corn-ear worm was established and the organism involved in a hitherto unidentified bacterial disease of growing tobacco was determined. In the soils

project, attention was given mainly to the development of reliable methods for determining potash, accepted methods for this purpose proving unreliable. The work on contagious abortion tended to throw doubt on the identity of the organisms stated to be the cause of this disease. The study of milk fever of cows was not taken up during the year except in a preliminary way.

The work with Hatch and other funds included numerous lines conducted at the station and in different parts of the State, frequently in cooperation with farmers and other agencies. In agronomy, experiments with forage crops were continued and special attention was given to soy beans, of which the station has a number of promising varieties for Kentucky. Work with corn included breeding experiments, ear-to-row tests in different localities, yield tests with seeds from different parts of the ear, and from graded and ungraded seed, and tests of rates and methods of seeding.

Breeding work was also carried on with wheat, timothy, and clover, and culture tests were made with alfalfa and other leguminous crops. As a result of selection and cross pollination of wheat, a variety quite resistant to lodging, of good quality and yielding capacity has been obtained. Fertilizer experiments on clover, tobacco, and wheat were carried on principally in the western part and experiments with forage plants in the mountain regions of the State. The work in tobacco breeding is progressing favorably in the development of a type with desirable leaf characters. A test was also made of the use of ferrous sulphate for the destruction of weeds.

The chemical division gave special attention to the analysis of forage plants to determine the influence of soil fertility on their composition, of tobacco raised in different parts of the State, limestones for agricultural purposes, and soil samples obtained from different sections of Kentucky. In addition studies were made of methods for determining carbon dioxid in soils and iron and aluminum in the ashes of plants and in phosphate rock. Attention was also given to the removal of potassium from the soil by the tobacco crop.

In animal husbandry, swine-feeding experiments were conducted principally for the purpose of comparing the economy of feeding hogs in dry lots and in pastures, and to compare the efficiency of grasses and leguminous plants as pasture crops for swine. These feeding experiments indicated that green rye, oats, barley, and wheat, when the plants are young and tender, are from about 6 to 12 inches high, and are as efficient as leguminous crops for supplementing corn in economical pork production. By analyses it was shown that in these very young grasses, dry matter contained about as large a percentage of protein as the dry matter of leguminous crops.

Other lines of work at the station during the year included studies of various insect pests and plant diseases, bacteriological examinations of potable waters, investigations relative to contagious abortion in mares and cows, and the preparation, distribution, and application of hog-cholera serum. The inspection work done by the station, which is large but separately provided for, now includes fertilizer, feed, food and drug, nursery, and seed inspection. A very satisfactory seed-testing apparatus was devised and described in station Bulletin No. 148, together with a report on the results of some experiments upon the effect of light on the germination of grass seeds. The entomologist made a study of the life history of Kentucky grape insects, and sufficient material has been gathered for a rather complete bulletin on this subject.

The station carried on cooperative experiments with farmers in tobacco spraying, in testing fertilizers with clover, tobacco, and wheat, in work with forage crops, in reclaiming unproductive land, and in the control of hog cholera. Cooperative work with this department was conducted with systems of rotation, tobacco breeding, culture, selections, and crosses of oats and selections of winter and spring barley, and with the use of sulphur in making up tobacco dips in the treatment of sheep for scab. It was found that the addition of sulphur did not increase the efficiency of the dip in destroying the scab mite. Soil studies were carried on in cooperation with the State Geological Survey.

The publications received from this station during the year were as follows: Bulletins 144, Information Concerning Food and Drug Inspection and Investigation; 145, Some Lessons from the Corn Shows—Corn Pests; 147, Common Insecticides and Fungicides, with Directions for the Treatment of Farm Pests; and the Annual Report for 1908.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation	15,456.77
Balance from previous year, State appropriation.....	8,181.14
Fees, including balance from previous year.....	41,121.94
Farm products, including balance from previous year..	12,082.51
Miscellaneous	423.17
Total.....	105,265.53

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The work at the Kentucky station covers many lines of importance to the agricultural industries of the State.

LOUISIANA.

- No. 1. Sugar Experiment Station, *Audubon Park, New Orleans.*
- No. 2. State Experiment Station, *Baton Rouge.*
- No. 3. North Louisiana Experiment Station, *Calhoun.*
- No. 4. Rice Experiment Station, *Crowley.*

Department of Louisiana State University and Agricultural and Mechanical College.

W. R. DODSON, A. B., B. S., *Director, Baton Rouge.*

The work at the Louisiana stations the past year was largely along lines previously described and the changes in the station staff were few in number. S. E. McClendon, assistant director of the State station at Baton Rouge, took charge of the substation at Calhoun as superintendent. The State appropriation for the biennium was \$10,000 annually, but in June, 1910, the amount was raised to \$17,000 for each of the next two years.

Progress was reported in most of the Adams-fund projects. The results of a long series of laboratory experiments with reference to the nonsugars of sugar cane indicated ways and means by which a decided improvement in the methods of clarification may be achieved.

A report was made on the bean anthracnose investigation in Bulletin 119 of the station. In connection with life-history studies of the disease it was found that the fungus will not stand a high percentage of acid in the medium in which it is grown, thus differing from any other anthracnoses. It was further found that it does not stand high temperatures and is killed out during summer in Louisiana. Certain soil organisms, especially *Fusarium*, were found to act against the disease. Valuable data regarding the mode of infection of the different organisms causing the cotton-boll rots were obtained, and the study of fig diseases was completed with the preparation of the results for publication. Owing to a very dry spring, red rot, rind disease, pineapple disease, and root rot of sugar cane were troublesome during the season, and considerable time was devoted to the study of their life history, their distribution, and the methods of combating them. The progress made in the alfalfa disease project has pointed out that the cause of the so-called stem girdle is insect injury, and that the infecting fungus is identical with the one causing sore shin of cotton and damping off in certain plants. The study of rice smuts was turned over to representatives of this department.

The bacterial work on raw sugar and sugarhouse products brought out the new and important fact that in the destruction of sugars by microscopic organisms, an optically active body is formed, whose presence in the sugar produces an error in analytical determinations

commonly practiced in the chemical laboratories. It is stated that the presence of this body in sugars makes the ordinary Clerget determinations of the sugars as unreliable as the single polarization methods.

Work was continued on the hyperimmunization of sheep for the purpose of producing a protective serum against anthrax. The results, as a rule, have thus far been somewhat uncertain, and it was found that the serum has a tendency to deteriorate rapidly.

The investigations on combustion in bagasse furnaces were continued during the year, and Bulletin 117 was published on this subject. Among the facts brought out in this investigation was that the heat value of dry bagasse per pound, which averaged 8,375 British thermal units in the tests made, varied but little and that the variation is apparently due to differences in ash content. Studies were made of the amount of air supplied through stack dampers as related to the amount of bagasse used for fuel, and an effort was put forth to determine the theoretical considerations which should govern the construction of bagasse furnaces, with special reference to the relation of consumption of bagasse to the amount of air supplied in the furnaces.

Investigations supported by Hatch and other funds were carried on by the different stations. At the State station at Baton Rouge the work was largely along lines previously reported. With cotton tests of varieties under boll-weevil conditions were made, and culture, fertilizer, and rotation experiments were conducted. Similar work was done with corn and oats. The forage-crop work was continued and enlarged, and attention was given particularly to tests with soy beans, cowpeas, peanuts, sweet potatoes, fodder beets, rutabagas, and other forage crops. Pasturage and feeding experiments were conducted with steers, pigs, and sheep, largely with reference to the use of various forage crops, including Lespedeza hay, and also with reference to the establishment of a satisfactory system of farming by which green crops may be grown the year round and protein supplied in cheaper feeds than cottonseed meal.

The work in horticulture included variety tests of garden crops, the determination of shipping qualities in vegetables, and the introduction and testing of new varieties. With tomatoes experiments were carried on to determine the canning qualities of some of the most productive sorts and their yielding capacity under different conditions of culture and when planted at different times.

The work of the veterinary department was largely of an advisory capacity in connection with the department of animal pathology and in aiding to establish a hog-cholera serum plant. Attention was also given to the execution of the plans for the eradication of the cattle tick and the suppression of infectious diseases.

The fertilizer and feeding-stuffs laboratory gave attention almost exclusively to routine work, comprising miscellaneous analyses of soils, fertilizers, feeding stuffs, waters, and other products. More analyses than during any previous year in the history of the station were made.

The experiments carried on by the sugar station at Audubon Park covered fertilizer, culture, rotation, and planting tests, and the study of factors influencing stubble cane, the effect of continuous cane culture on the soil, methods of irrigation, and tests of varieties and seedlings originating in Louisiana and in the Tropics, and also of introduced varieties of sugar cane. The work of the sugarhouse was primarily devoted to a study of methods of clarification as mentioned above. In addition to these investigations forage crops, fiber plants, semitropical fruits, vegetables, and other plants were tested, and facilities were provided for testing cane harvesters and agricultural implements. The annual demonstration of the Louisiana Sugar Planters' Association was also held at the station, in connection with which various kinds of agricultural implements, such as cane loaders, cane cutters, and other machines and devices of interest to the sugar planter, were on exhibition. This meeting was the most largely attended of its kind.

At the North Louisiana Experiment Station at Calhoun practically all the experiments previously outlined were continued with certain modifications. The work in general embraces rotation experiments with cotton, corn, oats, and cowpeas, culture and variety tests with cotton, testing soy beans, especially with reference to the influence of time of planting on maturity of seed, testing miscellaneous forage and fiber crops, and studying the influence of fertilizers on the quality of sirup from sugar cane. In addition, culture, variety, and curing tests were made with peanuts, and the grazing value of different crops devoted to the production of pork was compared. A new line of work was begun in an effort to establish a succession of grazing crops throughout the year for pork production. Attention was also given to growing corn for silage.

The horticultural branch of this station has now over 600 trees of seedling peaches under observation, besides seedling apples, pears, plums, and grapes. Breeding work with beans, cantaloups, and watermelons gave some good results and will be continued. Methods of cultivating peach orchards and utilizing winter cover crops were also under way. With potatoes, the question of home-grown versus northern seed was studied, and an effort was made to work out means by which northern Louisiana may grow potatoes to be used for seed farther south. Studies were also made on the germination of tubers from the second crop.

At the Rice Experiment Station at Crowley a building was constructed at a cost of \$3,500 without the completion of the interior. (Pl. II, fig. 1.) A 60-horsepower double-cylinder gasoline engine was installed at a cost of about \$2,500 for pumping water for irrigation. The work during the past year consisted of fertilizer tests, rotation experiments, and comparison of different methods of flooding, soil preparation, and irrigation. Of the 60 acres at the disposal of the station about one-half is used by the Bureau of Plant Industry of this department in testing over 300 varieties of rice. In the rotation experiments, peas, oats, spelt, clovers, Lespedeza, and rape were tried to determine their value for rotative cropping with rice. In June, 1910, the legislature made an appropriation of \$7,500 per year for the next two years for the maintenance of this station.

The station cooperated with this department in studies of varieties of rice, rice insects, evaporation, and irrigation in rice growing, the study of insects infesting sugar cane, and in testing plants contributed by the department. The station staff participated to some extent in the organization of corn clubs and other local agricultural societies, conducting farmers' institutes, and giving special lectures to farmers. The extension work is in charge of a separate officer, and is carried on in cooperation with the State commissioner of agriculture and with this department.

The following publications of the stations were received during the year: Bulletins 115, The Principles and Practice of Feeding, Including our Available Stock Foods; 116, Preliminary Report on the Anthracnose or Pod Spot Disease of Beans; 117, An Experimental Study of Bagasse and Bagasse Furnaces; 118, Corn; 119, Bean Anthracnose; Geological Survey Bulletin 8, Oil and Gas in Northwestern Louisiana, with Special Reference to the Caddo Field; Fertilizer Report 1908-9; Feed Stuffs Report, 1908-9; and the Annual Report for 1909.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation -----	13,737.60
University apportionment -----	600.00
Fees -----	4,500.00
Farm products-----	2,918.87
Miscellaneous -----	882.62
Total -----	50,639.09

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The work of the Louisiana stations was systematically prosecuted during the year along the lines well established and of particular importance to the agricultural industries of the State.



FIG. 1.—LABORATORY AT THE LOUISIANA RICE STATION CROWLEY.



FIG. 2.—SHEEP FEEDING BARN AT THE MONTANA STATION.

MAINE.

Maine Agricultural Experiment Station, Orono.

Department of the University of Maine.

C. D. Woods, Sc. D., *Director*.

The Maine Experiment Station celebrated its twenty-fifth anniversary March 9, 1910, with appropriate exercises. Dr. G. E. Fellows, president of the University of Maine, retired at the close of the college year and was succeeded by Dr. Robert J. Aley, professor of mathematics at the University of Indiana. The station came into possession of the new farm at Monmouth, and experiments were again taken up along certain lines of orchard management which had been held in abeyance as a result of inadequate facilities. This farm will also offer facilities for other lines of field work. Miss E. M. Patch, at her request, was made associate entomologist, with Dr. O. A. Johannsen as the head of the department.

In addition to an appropriation of \$4,500 for the printing of station bulletins and reports, the institution receives \$9,000 a year from the State for all the inspection work, and has the fees from testing creamery glassware.

The different lines of Adams-fund work of the station were continued, and good progress was made. In the work with poultry by the department of biology the growth of the organs of reproduction in connection with egg production was studied in its relation to the growth of the chick. The histology of the oviduct was worked out with the result that a much more complete and exact knowledge of the anatomy and physiology of the egg tube was gained than has ever existed. The questions of age and weakness in relation to progeny and the transmission of dominant qualities under favorable physiological conditions also received attention. An extensive experiment was carried on in the reciprocal crossing of Barred Plymouth Rocks with Cornish Indian Game for the purpose of combining into one strain the desirable characteristics of the two breeds. Observations on the growth of hybrids as compared with pure races were made by this department with corn and poultry.

In connection with its poultry-breeding work the station has shown that egg production is inherited in pure lines or within families showing the ability to transmit that quality. Biometric methods applied to the study of the factors which influence the hatching of eggs resulted in data indicating a small but still sensible correlation between fertility and hatching quality of eggs. It is believed on the basis of this result that if a hen under a given set of conditions produces eggs high in fertility, the fertile eggs will also run high in hatching quality, and vice versa. Other statistics collected in this

connection indicated no correlation whatever between winter egg production and fertility of eggs during the hatching season, and also showed that the higher the winter egg production the lower the percentage of fertile eggs hatched, and vice versa.

In corn-breeding work the isolation of the genotype in sweet and dent corn was followed by testing out different heterozygote types and rejecting the undesirable forms. Careful measurements of growth of the corn plant were made and accurate and full data on the growth of corn under Maine climatic conditions were collected for publication.

The work of the entomological department during the year was largely with plant lice, and especially with two closely allied species of *Macrosiphum*, which are often very difficult to distinguish. The only reliable basis of distinction of these two species, so far as known, was determined by this department during the year. Many of the food plants of the species were also determined. The life history of the alder plant louse was studied with a view to finding out whether the life cycle is completed without going onto the maple. Four rare aphid genera, *Sipha glyceriae*, *Mindarus abietinus*, *Symdobius oblongus*, and *Mastopoda pteridis*, were described during the year, and work on the gall aphids of the elm was also published. The investigations on the Chermes of Maine conifers were completed during the past season. The systematic and morphological work on the fungus gnats was also finished, and the extent of injury of certain species to the potato in connection with the development of potato scab was investigated. The maggots of diptera, including those of the house fly and the birch leaf bucculatrix, were also under observation.

The department of plant pathology continued work on the apple-disease project, giving attention particularly to the interrelation of several diseases and taking up new lines of work, specially on fruit spots and leaf spots of the apple. A new species of *Endomyces* which was isolated from decaying fruit of the apple in Maine was described and the results of inoculating apples with the fungus, its cultural characters, and a comparison of the species with other species of *Endomyces* and with species of other closely related genera were reported.

In the continuation of the potato-scab work, scabby potatoes were fed to different animals and the manure was applied to sterilized soil to observe the possible transmission. On some of the horse manure plats the potatoes were scabby, but on none of those where cow manure was applied. The treatment of infected soils by growing different kinds of crops was under test. Considerable progress was made in the study of the blackleg disease of the potato, especially with reference to the life history of the organism and the methods

by which the disease is spread and by which it may be controlled. The variation of fungi as a result of environment was observed incidentally to the studies of blackleg, rots, and other potato diseases.

Among the experiments carried on with the Hatch fund may be mentioned the work of rejuvenating an old and run-down orchard of 700 to 800 trees of Baldwins at Monmouth. Spraying work with Bordeaux mixture and other sprays entered largely into this undertaking, and good results were secured with lime and sulphur. Cultural methods for use in orcharding were put under test and high ridge, modified ridge, and flat culture for potatoes was begun. A top-dressing experiment with fertilizers on grass was also in progress, and a breeding experiment with oats was inaugurated at Monmouth.

Observations by the department of plant pathology made in the white-pine area of the State indicated that the so-called white-pine blight during the past season was not due to an active parasite, but was only of a transient nature, resulting from adverse weather conditions. This department during the year noted for the first time the occurrence of a yellows disease of the fall dandelion.

At the request of this department a bulletin, published as one of its Farmers' Bulletins, was prepared, giving a complete account of the methods of managing poultry in use at the station. Exact and detailed records were made of all matters concerning the poultry plant, including autopsies of all birds dying, etc. Plans for testing some of the promising new sweet-corn strains developed by the station in cooperation with the sweet-corn packers of the State were worked out. The station performs no extension work.

The following publications were received from this station during the year: Bulletin 168, The Fertility and Hatching of Eggs; 169, Two Epidemics of Potato Blight and Rot; 170, Apple Diseases Caused by *Coryneum foliicolum* and *Phoma mali*; 171, The Pine-leaf and Green-winged Chermes; 172, The Fungus Gnats of North America; 173, Chermes of Maine Conifers; 174, Blackleg—A Bacterial Disease of the Irish Potato; 175, Finances, Meteorology, Index; 176, The Ligaments of the Oviduct of the Domestic Fowl; 177, Insect Notes for 1909; and 178, An Endomyces from Apple.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	13, 000. 00
State appropriation	14, 500. 00
Fees	10, 500. 00
Miscellaneous.....	2, 566. 55
Total.....	55, 566. 55

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Maine station has established many of its lines of investigation on a high-grade research basis and is successfully pointing out the application of the results to the needs of the farmer.

MARYLAND.

Maryland Agricultural Experiment Station, *College Park.*

Department of Maryland Agricultural College.

H. J. PATTERSON, B. S., *Director.*

The lines of work pursued by the Maryland station during the year were essentially the same as those previously reported, and favorable progress was made. The changes in the station staff included the resignations of C. W. Nash, assistant agronomist, C. L. Opperman, associate poultryman, and the appointments of T. R. Stanton as assistant agronomist, C. O. Appleman to the position authorized in plant chemistry and physiology, and R. H. Waite as associate poultryman. G. E. Gage was promoted from associate biologist to biologist. The additions to the equipment made during the year included a new operating room and hospital for use in connection with the poultry disease investigations, a laboratory for work in plant physiology, two new greenhouses, and a cement-block mushroom house. One of the new greenhouses is set aside for research work in horticulture, while the other will be devoted to rose culture.

Considerable progress was made in a number of Adams-fund projects and certain lines of research were well advanced toward completion. In connection with the project on the rate of diffusion in the soil of different forms of lime, the study of the amounts of lime carried off in the drainage waters was continued and the laboratory work was checked with field experiments.

Considerable time was devoted to the problems relating to city milk supplies, special attention being given to the precipitation of the casein as a measure of differentiating the milk of different breeds of cattle and as determining the degree of its digestibility for infants and invalids. The study of the effect of leucocytes in milk combined microscopical and chemical work, and some of the results obtained were nearly ready for publication.

The poultry-disease investigations included the study of a tape-worm disease and the determination of methods for its control, as published in Bulletin 139 of the station, an investigation of the bacteria and animal organisms in the intestinal contents and mucosa of healthy chickens, ranging in age from those just hatched up to fowls two years old, and observations on the effect of complete cecumectomy upon the metabolism of the domestic fowl to determine the part which the ceca performs and its relation to disease.

The entomological project on parasitic Hymenoptera was continued during the year, and many facts with reference to the life history of certain species were worked out.

Work on the projects in plant physiology consisted of investigations regarding the effect of chemicals injected into plants on their physiology and structure, the effect of chemicals on weeds to determine methods for their destruction, and the relation of chemicals to mutations in plants. The effect of chemical treatment of pollen was also studied and observations were further made on the use of fertilizers in relation to mutation and changes in cell structure in a large number of varieties of fruits, vegetables, and flowers.

The station also had in progress under the Hatch and other funds a large number of other experiments. The work in the horticultural department was divided among the workers, each one being placed in entire charge of certain lines of work. Under this arrangement C. P. Close worked extensively on nut trees, especially walnuts and pecans, and worked out a successful method of bench grafting. In addition, attention was given to peanut and mushroom culture, orchard heating, apple breeding, fertilizers, and cover crops for apple orchards, and experiments with the sweet cherry. In the orchard-heating work, carried on in the spring of 1910, the temperature of the orchards was raised 8 degrees over the adjoining regions. Breeding work with geraniums and pears, culture tests with strawberries, raspberries, tomatoes, and muskmelon, testing preserving fluids for fruits, propagating apple and pear by cuttings, feeding plants with copper solutions for disease resistance, the study of reciprocal influence of scion and stock, and experiments with peaches were in charge of W. R. Ballard. T. H. White conducted experiments with asparagus, cabbage, celery, potatoes, sweet potatoes, and onions, made observations on the variation of plants due to excess of plant food in various forms, made fertilizer tests with gooseberries and currants, and devoted some time to the study of carnations, chrysanthemums, sweet peas, roses, and violets.

In agronomy the work was grouped under three heads: Soil and fertility tests, experiments with cereals, forage and green manuring crops, and tobacco experiments. Tests were made of different forms and sources of phosphoric acid and of various nitrogenous fertilizers, different forms of lime were compared, and a study was made of the use of green manure, deep plowing, and of farm manures for renovating soils and maintaining their fertility. The particular crops used for green manures included cowpeas when followed by wheat and corn, and crimson clover when followed by corn. In this connection some nonleguminous crops were grown for the purpose, and the value of lime was tested when used for growing green manuring crops. Breeding work, variety testing, and culture experiments were

conducted with corn, wheat, oats, barley, spelt, emmer, alfalfa, clover, cowpeas, and sweet corn. Hairy vetch was grown to determine the profitable production of seed. The tobacco work conducted in cooperation with this department comprised tests of varieties, improvement of the crop by seed breeding and selection, fertilizer tests, residual effects of fertilizers applied for tobacco on the yield and value of other crops in the rotation and tests of other crops as a substitute for tobacco in the rotation followed.

The dairy work consisted of studying the effect of the system of housing of cows on milk production and health, and studies of bovine tuberculosis, the relation of services to abortion, milk substitutes in calf feeding, and means for cheapening the cost of production of dairy products. Cooperative work with farmers in testing cows was also carried on. Work in animal husbandry was principally confined to swine and the experiments in progress related to the cost of raising pigs to the weaning age, the comparison of dry feed in hoppers with the same feed as slop, the comparison of soft coal, wood charcoal, and tonic mixture as a supplementary feed or corrective, and the determination of a balanced ration as indicated by the hog's appetite.

Entomological work was largely carried on in cooperation with the State horticultural department. Experiments were made for the control of the San José scale, the dipping of nursery trees and seedlings in different insecticides for the control of insect pests was tested, and observations on the agencies and means by which San José scale is distributed were made. Studies were made of the life history and of the methods for controlling the codling moth, the peach-tree borer, the corn-ear worm, and the plum curculio. Attention was also given to the destruction of woolly aphis and green aphis, and to the relation of the house fly to disease and the means for its suppression. This department devoted much time to the orchard and nursery inspection provided by the State horticultural law. In this work over 700 nests of the brown-tail moth were discovered in imported nursery plants and were destroyed to prevent distribution.

The studies relating to plant diseases had reference to their distribution and methods of control, particularly the use of Bordeaux mixture and concentrated lime-sulphur as sprays. The effects of treatment for the control of potato scab on germination and the effects of seed of diseased plants on the product were also observed, and a study was made of the diseases of roses in the greenhouse.

The botanist gave attention to the distribution of weeds and grasses, the determination of the variation within the species of some wild plants and whether the variations are hereditary, and to the determination of the purity and vitality of seed.

In the pathological and chemical studies at the station considerable attention was given to peach yellows, water core in apples, spraying

solutions for combating plant diseases, including peach yellows, developing perfectly safe fungicides for fruits, methods of destroying weeds, and the selection and testing of seeds. It was discovered that a 5 per cent solution of formalin used for disinfecting the seed tester retarded germination. The results of work on the spraying of weeds showed that when some sprays are soon washed off the weeds will recover, while with strict poisons that was not the case. The plasmolyzing sprays acted best in dry and warm weather. It was further found that vapor from phenol-impregnated fertilizer may be injurious to plants, while a similar fertilizer containing naphthalin had no injurious effect.

The following publications of the station were received during the year: Bulletins 133, Cabbage Experiments and Culture; 134, The Brown-tail Moth—The House Fly—the Mosquito; 135, Butter Making in Maryland; 136, Whipped Cream; 137, The Angoumois Grain Moth; 138, The Poultry Industry in Maryland; 139, A Tape-worm Disease of Fowls; 140, The San José Scale and the Osage Orange Hedge; 141, Corn—Variety Tests—Seed Breeding, Selection, and Testing; 142, The Codling Moth; 143, Plant Diseases and Spray Calendar; and 144, Apple Culture.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation	11,500.00
Farm products	8,189.46
Balance from previous year.....	116.91
Total	47,806.37

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Maryland station made steady progress during the year, but with the growing interest in agriculture in the State the demands upon the institution are increasing to such an extent that a broader organization will be required to keep up the amount of experimental work the station is doing.

MASSACHUSETTS.

Massachusetts Agricultural Experiment Station, *Amherst*.

Department of the Massachusetts Agricultural College.

W. P. BROOKS, Ph. D., *Director*.

At the Massachusetts station the new entomological building, providing increased facilities for experimental and research work, was completed during the year. In addition to the appointment of B. N.

Gates as apiarist, the station staff was increased by appointing assistants in horticulture and in botany and plant pathology. C. H. Fernald, for 24 years entomologist of the station, retired from the position, and H. T. Fernald was appointed as his successor. Several other changes in the minor positions also took place.

The State legislature made an appropriation of \$15,000 for the purchase of a cranberry bog, and a tract of 23 acres, including 12 acres of made bog, was purchased at East Wareham, and possession was secured after the close of the fiscal year. The tract has ponds on three sides and is provided with a pumping plant with sufficient capacity to flood the bog in seven hours.

A demonstration farm was started at Sandwich by private beneficence. A local physician left about \$25,000 and a small farm for conducting experiments and demonstrations for the general benefit of the people. The director and the pomologist of the station and the director of extension work constitute an advisory committee to the board of trustees of the fund.

Under the Adams fund the work with asparagus included a study of the effects of fertilizers on rust and on the composition of the roots. It was found that the increase of nitrogen in the fertilizer up to a medium amount was accompanied by an increase in nitrogen in the roots. A study of the carbohydrates and ash content of the roots was also made. In cooperation with this department, work on rust resistance by means of selection and crossing was carried on.

In the work on cranberry insects special attention was given to the fireworm and the fruit worm, and the food plants, life history, etc., of a new species of *Gelechia trialbamaculella*, which attacks the cranberry, were studied. Efforts were made to determine the most vulnerable point in the life of the fruit-worm pupæ, and the effects of different methods of treatment were observed. A study was also made of the pupæ of the girdler and of methods for its destruction. An experiment to determine the relation of bees to the fertilization of cranberry blossoms seemed to show that bees were necessary in this connection, and that bumblebees were more efficient than honeybees. The study upon the principles underlying the use of fertilizers in cranberry culture was continued, and for this purpose an artificial cranberry bog, enabling the more thorough control of conditions in experimental work than is ordinarily possible, was constructed on the station grounds.

In the milk-secretion project, further attention was given to more accurate methods for separating the different fatty acids as preliminary to the study of milk secretion. The results of a study on the effect of molasses on the digestibility of hay indicated that molasses causes a distinct depression in the digestibility of the other feeds

in the ration. In connection with this project the effect of lactic acid in the ration was also considered.

The project on arsenicals and their injury was confined to the preparation by the chemical department of practically pure Paris green with the amounts and kinds of impurities actually known. Arsenate of lime was also prepared practically pure, and similar work on arsenate of lead was taken up. The digger wasp was studied during the year mainly from the standpoint of its economic importance.

The investigations on the relation of climate to the development of crops in health and disease included the study of light, particularly as related to greenhouse construction, the relation of moisture to blight of lettuce and melons, and the relation of heat, light, and moisture to wilt. Attention was further given to the development of methods for determining the amounts of heat and light required in crop production, and to malnutrition and overnutrition in relation to disease.

The study of Mendelism was continued with 18 varieties of beans variously crossed, in tracing principally the factor of color in the flowers, the plant in general, and the seed coat, and of stringiness in the pods. Similar studies were also made of the color in the leaf and flower of nasturtium, and biometrical work was carried on with peas. The effect of variation in the apple, as due to climatic influences, was studied, and in this connection it was found that variation in form, as due to climate and most often to proximity to bodies of water, was very marked.

Under the Hatch fund, the chemist studied the digestibility of various samples of prize corn and found that no practical differences existed. Determinations of the amount of dry matter in large leafy varieties of corn and in smaller-leaved sorts indicated that the amount of dry matter in the leaves and ears of both types is about the same and that the larger varieties show an increased yield in stalk and in the amount of water. The digestibility of alfalfa and clover at different cuttings was studied, and feeding experiments were made with dried-molasses beet pulp and ordinary beet pulp in comparison with corn meal for cows. Work was continued on the protein requirement for dairy cows, the quantities used in the test ranging from $1\frac{1}{2}$ to 3 pounds of protein per day.

Cooperative experiments were carried on with this department and with two tobacco growers in the State for the purpose of comparing one of the new varieties of Habana with the ordinary varieties, and of priming with the usual practice of cutting the stalks and hanging them up for the leaves to cure. A study was also made of the degree of maturity for priming. Among other lines of work conducted by

the agricultural department, feldspar was compared with potash salts for grass and clover, and several series of fertilizer tests with different families of crops were conducted in field experiments. In addition to these experiments tests of muriate and sulphate of potash for potatoes, raspberries, asparagus, and other crops were made. The regular field experiments in progress for many years and the pot culture work comparing the availability of different sources of nitrogen were continued. Three cuttings were made of alfalfa grown at the station. Cooperative work with alfalfa was carried on in about 24 experiments distributed in different parts of the State. As a result of the methods advocated by the station, the crop made an excellent start in all localities.

The horticultural department studied the influence of stock and scion on the apple with special reference to color, and carried on pruning experiments with apples and other orchard fruits as well as small fruits. In cooperation with the agricultural department, the effect of high-grade and low-grade potash fertilizers on fruit trees was studied at the station and elsewhere.

The department of vegetable physiology and pathology made microscopic examination of samples of seed to determine the possible contamination from plant diseases, work on the perfection of seed-separating devices for cutting dodder out of alfalfa and for other similar purposes, and studied plant diseases, including malnutrition, together with methods for their prevention and control. In this connection market-garden crops and a large number of ornamental plants were given attention. Experiments relating to the chemical treatment of soil were continued for the purpose of observing the effect of formalin and other chemicals on the prevalence of potato scab.

The entomologist studied methods of treatment for cabbage maggot and methods of control of the Marguerite fly. Cooperative spraying experiments were conducted to determine methods for the better control of onion thrips, and the dates of hatching of the young of the oyster-shell scale, scurfy scale, and pine-leaf scale were observed to determine the best time for spraying. The control of wireworms on corn was given attention, and a parasite of the asparagus beetle was studied with reference to its life history.

The veterinarian gave some attention to bovine tuberculosis in attempting to transmit the disease to calves by feeding them skim milk, and to the transmission of Japanese farcy in horses by inoculation.

The following publications were received from this station during the year: Bulletins 129, Bee Keeping in Massachusetts; 130, A Summary of Meteorological Observations; 131, Inspection of Commercial Fertilizers; 132, Inspection of Commercial Feed Stuffs; Meteorological

logical Bulletins 246-257; Circular 17, An Act to Regulate the Sale of Concentrated Commercial Feed Stuffs; and the Annual Report for 1908, parts 1 and 2.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation-----	13,500.00
Individuals-----	544.17
Fees-----	5,970.00
Farm products-----	3,208.73
Miscellaneous-----	6,387.84
Balance from previous year-----	5,538.50
Total-----	63,149.24

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The field of activity of the Massachusetts station continues to grow, and with it the demands upon the station are steadily increasing. With the extension work organized on a broader basis, the efficiency of the station in pursuing experimental and research work will be materially enhanced.

MICHIGAN.

Experiment Station of Michigan State Agricultural College, East Lansing.

Department of Michigan State Agricultural College.

R. S. SHAW, B. S. A., *Director.*

The year was marked by important improvements in equipment, changes in organization, and additions to the staff of this station. The new agricultural building was completed and furnishes excellent office and laboratory facilities for several of the station departments. A greenhouse, 24 by 40 feet, and a brick annex to the botanical building, 33 by 61 feet, with two stories and basement, and costing about \$13,000, were constructed during the year.

Dr. W. J. Beal, long connected with the college and station as botanist, was made professor emeritus and was succeeded in active charge of the department by Dr. E. A. Bessey, of the Louisiana University. V. M. Shoesmith, of the Maryland station, was appointed head of the department of field crops. J. F. Baker was appointed forester, W. A. Wentworth investigator in soil bacteriology, and O. B. Winter assistant chemist. A. R. Potts was made field agent in soil and crop extension work, and M. A. Yothers, assistant entomologist, resigned.

The organization of the agricultural work in the college and station now consists of the departments of animal husbandry, dairy hus-

bandry, poultry, soils, forestry, and farm mechanics. As at present organized forestry and poultry are not full research departments. This arrangement on the whole, however, secures a definite and efficient organization of the agricultural work. The larger administrative and business affairs of the station are in charge of the director, and the scientific work is under the immediate supervision of the vice director, Dr. C. E. Marshall.

An additional section of land was devoted to the Chatham substation, and the work there was enlarged during the year. Preliminary steps were taken to revive work at Grayling on the jack-pine plains, where some experiments were made several years ago and where settlers are now being induced to locate.

The Adams-fund work is confined to a comparatively small number of projects, on which good progress was made. Two technical bulletins were issued during the year as a result of the study upon the bacteriological factors influencing the keeping quality of butter. Investigations on hog cholera were also actively prosecuted. Some of the results of this work, particularly those relating to the agglutination reactions of hog cholera during the process of serum production, have been published, and a second report on the same subject is ready for the press. A study of the Grand Traverse, or Lake Shore disease, was reported upon during the year. The information secured showed that the trouble is dietary, and it is thought possible that improved methods of feeding and caring for stock may either prevent or cure this disease. The cooperative study of agents rendering available the insoluble constituents of soil was enlarged, especially on the chemical and bacteriological sides. The botanist planned to take part actively in this investigation from the standpoint of plant physiology. Pot experiments were begun during the year on changes which go on in mixtures of peat and light sandy soil from the jack-pine plains, under different systems of fertilizing and management.

The chemical study of the organic nitrogenous compounds in peat was reported upon during the year. It was found that there are no nitrates in the different types of Michigan peat soils examined and that practically all the nitrogen in the peats is of organic nature, largely in the form of monamino acids, about one-fourth in the form of amids, and the rest represented by diamino acids. It was further found that through weathering the organic nitrogenous bodies in brown peat change quite slowly, but that the amount of water-soluble nitrogen is somewhat increased thereby.

Work was continued on fungus diseases of insects and on the relation of the respiratory system of insects to the action of contact insecticides, but owing to the illness of the entomologist no very

marked progress was made. Parasites of larch and tamarack insects received special attention.

Among the lines of work conducted with other funds, the preparation and distribution of hog-cholera serum received special attention. On account of the shortage of funds for this work the serum is now being sold at 4 cents per cubic centimeter, to cover the cost of preparation and distribution.

Experiments were continued in breeding and feeding farm horses of the Percheron and Clydesdale breeds, breeding up a grade dairy herd, herd testing, trials of home-grown and supplementary feeds for hogs and of succulent rations for sheep, and in determining the relative merits of farm poultry houses. Experiments were also carried on in the rearing of calves on skim milk and supplementary feeds and the production of baby beef. It was found that baby-beef production by the skim-milk method was much cheaper and gave better results than by the suckling methods. When marketed at an average age of 18 months, calves raised on skim milk weighed 966 pounds, while those that had suckled their dams weighed 995 pounds. The skim-milk baby beef was produced for \$5.23 per hundredweight, as compared with \$6.73 per hundredweight for the others.

In a feeding experiment with horses it was found that a ration made up of shredded cornstalks, oat straw, and hay for roughage, together with ear corn, oats, and a mixture of dried-beet pulp, bran, and oil cake for concentrates, in addition to a few carrots daily, may be profitably substituted for a ration of oats and timothy hay in winter feeding.

Studies were made of the chemistry of lime-sulphur mixtures, on soil temperatures, on the construction of silos, and on soil drainage.

Extensive breeding experiments with plants were carried on, including breeding of wheat, oats, alfalfa for seed and forage, clover, cowpeas, soy beans, and field beans. Tests of varieties of corn were begun at the station and at different places in the State. Tests of varieties of wheat were also made at the station, and an extensive series of plats to study questions of soil fertility in connection with a rotation of corn, wheat, and clover were laid out on a new area for the purpose on the south farm of the college. Additional land was also assigned to the forestry department, which already has extensive plantations on this farm.

Experiments with fertilizers for potatoes were undertaken at the station and in cooperation with farmers, and work was also conducted with sprays for potatoes; fertilizers for apples, peaches, and grapes; cover crops for orchards and vineyards; on cold storage of apples; propagation of apples from suckers, from fruiting wood, and from selected trees; propagation of peaches from pits from different

regions; strawberry breeding; and with resistant strains of peaches. A study of faulty pickle fermentation was made during the year.

The station has been active in promoting the formation of live-stock and other farmers' organizations and getting in touch with those already organized, in this way increasing its influence throughout the State. It is planned to add assistants to the staff to relieve the members in charge of research work from the growing and heavy correspondence and extension work. Five classes of publications are now issued—regular bulletins, special bulletins, technical bulletins, circulars, and annual reports, all of which are printed by the State.

The following publications were received from this station during the year: Bulletins 254, Wintering Farm Horses; 255, Cement Silos in Michigan; 256, Fertilizer Analyses; 257, Rearing Calves on Skim Milk and Supplementary Feed; 258, Insects of Field Crops; 259, Bean Growing; Special Bulletins 49, Grape Spraying Experiments in Michigan, 1907–8; 50, The Grand Traverse Disease or Lake Shore Disease; Technical Bulletins 1, Keeping Qualities of Butter; 2, Keeping Qualities of Butter; 3, Studies of Agglutination Reactions in Hog Cholera during the Process of Serum Production; 4, Organic Nitrogenous Compounds in Peat Soils; Circular 6, Hog-cholera Serum; and the Annual Report for 1909.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation-----	6,122.07
Fees-----	4,080.00
Miscellaneous-----	345.22
Balance from previous year-----	1,634.32
Total-----	40,181.61

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

With an improvement in the equipment and an increase in available funds, both the scientific and practical work of the Michigan station has been greatly broadened and strengthened.

MINNESOTA.

Agricultural Experiment Station of the University of Minnesota,
University Farm, St. Paul.

Department of the University of Minnesota.

A. F. Woods, M. A., *Director.*

A number of changes took place in the station staff during the year. Harry Snyder, of the division of agricultural chemistry and soils, resigned, and Ralph Hoagland, formerly of this department, was placed

in charge. J. A. Hummel and A. D. Wilhoit, assistants in the same division, resigned, and their places were filled by the appointment of R. M. West and G. W. Walker. John Spencer was placed in charge of the hog-cholera investigations, vice C. A. Pyle, resigned. E. C. Higbie was appointed superintendent of the new substation, established in connection with the agricultural school at Morris. William Robertson, superintendent of the Crookston substation, died in January, and C. G. Selvig was appointed to fill the place.

After the close of the fiscal year, on July 11, occurred the death of S. B. Green, connected with the institution since 1888 in the capacity of horticulturist and forester, and the work of the department was temporarily placed in charge of Leroy Cady, and that of forestry in charge of E. G. Cheyney. The work in animal husbandry and dairying, formerly under separate heads, was combined under T. L. Haecker, and Andrew Boss was placed in charge of farm management.

During the year a new vaccine building was erected and equipped especially for the manufacture of virus, at a cost of approximately \$10,000. Considerable new equipment was added to the soils laboratory, and a denatured alcohol plant was provided at a cost of \$6,000 and equipped for experimental investigations in the production of alcohol, the capacity being 50 proof gallons of alcohol per day. A thoroughly modern baking and testing laboratory for studies in connection with wheat investigations was installed, with electric baking and drying ovens, sponge cases, an experimental flour mill, and other necessary equipment.

The old Indian school at Morris, in the Red River Valley, was turned over to the State to be used for an agricultural school and experiment farm. The State has appropriated for the current year \$5,000 for the school and \$5,000 for the farm, which contains about 400 acres. The citizens have agreed to supplement this appropriation up to \$15,000.

The various departments of the station are provided with funds for necessary field and demonstration work from the current expense appropriations of the university or by special appropriations for specific cases. The department of dairying and animal husbandry has \$2,500 a year for special field work in dairy extension and the same in poultry extension. The department of entomology has a special State fund of \$5,000 for field work in its line. The veterinary department has \$2,000 for hog-cholera work, the chemical department \$1,000 for soil investigations, the agricultural engineering department \$2,000 for drainage investigation and demonstration, the department of botany and plant pathology \$400 for investigating plant diseases, and \$1,000 for the eradication of noxious weeds, and the department of agriculture has \$2,000 for tobacco culture. A special appropria-

tion of \$50,000 for the biennium was granted by the last legislature for extension and démonstration work and a correspondence course in agriculture.

Progress during the year in the investigations under the Adams Act is reported. In the study of food requirements in milk and beef production, a vast amount of data is being accumulated as to the use made of the feed and its bearing on standards for feeding. During the year 18 animals were slaughtered for complete analysis.

The work in the chemical department was interrupted by changes during the year, but studies were made on the humus in the series of rotation plats as compared with those cropped continuously with grain, and investigations were made on the combination of mineral matter with humus in its relation to cropping, the idea being to determine the effect of the growing crop on the humus content and on its content of mineral matter.

The entomologist continued his work on *Bruchophagus funebris*, and inaugurated and used a successful method for accomplishing the fertilization of clover blossoms rendered immune to the attacks of insects, by using bumblebees inclosed with the blossom in cages. It is believed that this is the first time that clover has been fertilized in this artificial way. The work on *Empoasca mali* and *Macrosiphum granaria* is practically closed out, and the results secured in the study of the cabbage maggot were prepared for publication.

The breeding project in horticulture was continued on the fruit-breeding farm at Excelsior, an 80-acre tract about 25 miles from the station. This farm is surrounded by lakes and is said to be one of the best localities for orcharding in the State owing to the equitable temperature. The farm was purchased by the State, which makes an annual maintenance appropriation of \$2,000, and a special appropriation for horticultural crops of \$1,000. A large number of strawberry seedlings were planted and selections made from them. About 1,500 crosses of strawberries were made in the greenhouse and the seeds planted. Several thousand plum and raspberry seedlings are grown for comparison. Careful records are kept for the purpose of securing data regarding inheritance of various morphological and physical characters in the species and varieties under investigation. As compared with its original outline, this project has broadened to include a considerable number of fruits and has become very extensive in scope.

In the investigation of stable ventilation during this year, evidence was obtained for the first time that an animal is apparently injured by close confinement in an excessively foul stall and atmosphere. In one animal there appeared quite regularly during the confinement periods, various abnormal constituents in the urine, the most important of which were blood and albumin. Viscosity of the blood was

increased and the opsonic index was lowered. Much attention was given to the study of the effect of imperfect ventilation upon disease resistance by investigating the phagocytic power of the leucocytes. For the purpose of this project a urine harness was made together with other equipment, and a stall fitted up in which the urine could be collected.

The work on the rusts of cereals is conducted on a 2½-acre field where a large number of individuals and hybrids are grown from which selections are made. An accurate system of causing a rust epidemic was developed, and laboratory experiments were conducted particularly with reference to spore germination. Various physiological and other experiments with regard to rust questions were carried on, and a bulletin prepared in cooperation with the Bureau of Plant Industry was submitted for publication.

In addition to the Adams-fund projects, many lines of work supported by Hatch and other funds were in progress. The department of botany and plant pathology continued its work on diseases of plants, botanical features of weeds, and on weed seeds and seed mixtures. A large number of hybrids of cereals were tested for their rust resistance. Some of the experiments on smuts of cereals were completed and the results prepared for publication. Extensive experiments were also conducted on aster blight, damping off of coniferous seedlings, potato diseases, particularly internal brown rot, fruit rot of tomatoes, and an unknown cucumber disease. A large number of botanical determinations of weeds were made during the year, and spraying experiments for the destruction of weeds were conducted. About 800 tests for purity and germination of seeds were made.

The chemical department conducted cooperative fertilizer experiments on 15 farms in the State, and made a survey of 22 demonstration farms and 4 substation farms as to soil type and inherent fertility. Equipment was installed and preparation was made to begin the study of the effect of time of cooking on the composition of cereal breakfast foods. This department was also ready to undertake experiments in the production of alcohol from the cheaper plants and residues.

The entomologist worked on the life history of the clover-seed chalcis and of the confused flour beetle. He also made observations on the San José scale to determine whether it would withstand the winters, on methods of combating grasshoppers in the field, and on the efficiency of insecticides.

The principal investigations and experiments conducted by the agriculturist during the year were along the lines of plant breeding, crop rotation, cost of crop production, and quack-grass eradication. Under the special appropriation for the eradication of weeds, a

40-acre farm was rented for a 5-year period to test and determine methods for the eradication of quack grass. In connection with this work spraying did not prove very effective. Crop improvement and plant breeding were carried on with spring and winter wheats, fall rye, oats, barley, flax, corn, sugar beets, mangels, alfalfa, clovers, timothy, cowpeas, soy beans, and hemp. A series of about 15 corn-breeding stations was maintained in different localities of the State.

Under the direction of this department numerous experiments are in progress on methods of developing varieties or strains of the cereal crops. The development and distribution of new varieties among the farmers of the State were continued during the year with much success. A new variety of winter wheat, Minnesota No. 529, and 3 varieties of oats, Minnesota Nos. 261, 281, and 295, which out-yielded the ordinary grains by 15 to 25 per cent, were distributed. Among the earlier varieties originated and sent out by the station may be mentioned Minnesota No. 169 wheat, No. 26 oats, No. 13 corn, and No. 25 flax, which have become known commercially and are now quite widely grown in Minnesota and the adjoining States.

The agriculturist is also in charge of the farm-management work on the demonstration farms. The farmer who allows his farm to be used for demonstration receives an outline of the plan of farming from the station, and keeps reasonably complete business records. In addition to these demonstration farms there are about 30 farms on so-called statistical routes where the cost of production was given special attention. The statistical work is pursued in cooperation with the Bureau of Statistics of this department, which defrays part of the expense. From these two sources considerable data with reference to farm management was accumulated.

A feature of the animal-husbandry work was a study of the feed consumed by each cow in the dairy herd in relation to the milk, butter fat, and solids-not-fat produced. A bulletin covering the record of the dairy herd for a period of 10 years was prepared for publication. A record was also kept of the feed consumed and growth made by the calves and heifers in the dairy herd, covering the period from birth to the completion of the second year.

The veterinary department gave special attention to hog cholera and swamp fever. The hog-cholera serum produced gave very promising results. The actual results up to March 1, 1910, were as follows: In infected herds 69 out of 1,604 vaccinated hogs died, and out of 76 unvaccinated animals in infected herds 70 died. Of 982 sound hogs treated with a full dose of tested serum 12 died. All vaccinated hogs were tested by inoculation or exposure. The total amount of serum produced up to February 8, 1910, was 98,189 cubic centimeters, or enough to protect 4,800 average hogs.

It was observed during the year that pigs from immune sows appear to be born with very high resistance to cholera. This natural immunity was found to disappear gradually, but was sufficient up to at least 5 weeks of age to make it possible to inoculate such pigs with very high virulent blood with an unimportant percentage of loss. A new operating table with hoisting apparatus was devised by this department, by means of which hyperimmunization and serum production is much facilitated. Work was also done with antituberculosis vaccine, and its actual working efficiency under ordinary farm conditions was further studied. The swamp-fever work was carried on in cooperation with the Minnesota State Live Stock Sanitary Board and the Bureau of Animal Industry of this department.

The station conducted cooperative work with farmers in experiments to control hog cholera, in the spraying of plums and apples, in combating grasshoppers, and in the study of special types of farming, such as potato growing, ensilage, feeding, and the cost of operating large farms in plant breeding with different farm crops. Cooperation was also conducted with the Bureau of Plant Industry in the study of rust of cereals and of sorghum smut, as well as in making a plant-disease survey of the State. At the request of the Bureau of Entomology of this department the station acts as deputy inspector of all nursery stock imported into Minnesota. The station also performs the State nursery inspection. Cooperative plant-breeding work is carried on with the Bureau of Plant Industry, and in this connection studies are made to provide a systematic nomenclature of varieties of barley.

A special State appropriation has made it possible to organize an extension department which cooperates with all the other departments of the station in all kinds of extension work. This department publishes a periodical for the farmer's library for which material is furnished for the various departments of the station and which also furnishes material to the papers of the State and prepares special articles for the general press and for agricultural journals. Matters bearing on special subjects are treated in special extension bulletins and circulars. Twenty demonstration farms scattered throughout the State were conducted by this department in cooperation with the station. Each farm was surveyed by soil experts, drainage maps where necessary were supplied, and cropping systems and farm organization were outlined. The station through the extension department furnishes only the advice and direction, and the results so far secured seem to promise that the plan will be successful.

The following publications of this station were received during the year: Bulletin 116, Report of the Northeast Experiment Farm at Grand Rapids, Minn.; and the Annual Reports for 1908 and 1909.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	12,774.58
Balance from United States appropriations for 1908-09--	225.42
State appropriation-----	40,185.87
Farm products-----	6,212.19
Total-----	74,398.06

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The scientific work, together with its application to agricultural practice accomplished by the Minnesota station, is of the greatest value to the State and to other sections of the northern Mississippi Valley. The results of the work will unquestionably assure the continued support and appreciation of the people.

MISSISSIPPI.

Mississippi Agricultural Experiment Station, *Agricultural College*.¹

Department of Mississippi Agricultural and Mechanical College.

J. W. Fox, M. S., *Director*.

During the year W. L. Hutchinson was succeeded as director by J. W. Fox, assistant director of the Delta substation, and was appointed director of farmers' institutes and professor of animal husbandry. J. A. McLean resigned as animal husbandman and was succeeded by E. R. Lloyd, formerly director of farmers' institutes. A. Smith, who had been placed in charge of the Delta substation, accepted a position as assistant in animal husbandry in the extension division at Clemson College, South Carolina, and was succeeded by R. L. Shields. W. R. Perkins, agronomist, resigned to accept a similar position at the South Carolina station. The poultry work was placed in charge of W. F. Kirkpatrick, of the Rhode Island station. Under a new State law, a single board of trustees was appointed for several of the State institutions, including the Mississippi college and station.

The Adams-fund project, involving studies on the breeding of mules, was continued as originally outlined, and detailed records of the progeny were kept. Data on the cost of feeding mules were collected incidentally as the work was carried on. The animals were kept in first-class condition, and the feed for them was grown on the station farm.

In the cottonseed-meal project, pursued by the bacteriologist and the dairyman, physical observations were made on cows, and their

¹Telegraph address, *Starkville*; express and post-office address, *Agricultural College*; freight address, *A. and M. College Station*.

blood, urine, etc., were subjected to microscopical and bacteriological examinations. Some influence with reference to the number of red and white corpuscles of the blood was observed as a result apparently of feeding the meal. It was also indicated that feeding cottonseed meal affects breeding unfavorably. This work was extended to hogs, where it was found that the effects of feeding the meal included a marked decrease in the red corpuscles of the blood, and that the length of resistance to the injurious effect varied in different animals.

In the cotton-anthraxnose project studies were made of the physiology and ecology of the disease, and in connection with the work selection of varieties for disease resistance was followed.

The entomological department pursued work on its several projects, recorded the data secured, and prepared some of the material for publication. Studies of scale insects were made in the insectary. Special work was done on a number of species attacking pecan trees, considerable time was devoted to the investigation of the peach-tree borer, and some work was done on the bean-leaf beetle, but no attention was given this year to the sugar-cane beetle.

The different departments of the station also pursued various lines of work under the Hatch fund. In animal husbandry experiments with beef cattle were made to determine the cost of wintering, and steers were fed cottonseed meal while on pasture. Pig-feeding experiments were conducted to determine the relative merits of a number of pasture and forage crops. Some of the results secured showed that cottonseed meal can be fed to beef steers on grass with profit and that grass is a much cheaper form of roughage than cottonseed hulls for feeding with cottonseed meal. This department has a large acreage at its disposal, but all the land is not actually required for experimental purposes.

Feeding tests were also made in dairy husbandry to compare wheat bran with corn silage as a feed for dairy cows, and an experiment was begun for the comparison of soiling, pasturing, and the use of purchased feeds in dairy farming. In these tests 1 ton of silage was about equal to 292 pounds of wheat bran. Data were also collected on the cost of raising heifers on purchased feeds.

Work in agronomy was pursued along much the same lines as heretofore. A large share of the land assigned to this department was in use for rotation experiments. A change in its leadership occurred during the year, as mentioned above, and the work is now in charge of the director of the station.

The entomologist made observations on pine-nursery insects, sawflies, chinch bugs, and other pests. The results of observations on the spread of the boll weevil obtained in cooperation with this de-

partment were prepared for publication. In addition to the experimental work, from 5 to 6 weeks were devoted to nursery inspection.

The horticultural department of the station carried on variety tests with strawberries, peaches, plums, apples, pecans, grapes, ornamentals, and other horticultural crops, and made spraying tests for the control of curculio, brown rot, and other insect pests and plant diseases. Special attention was given to the strength of solution adapted to local conditions.

The poultry department concerned itself principally with growing good fowls under ordinary conditions and breeding them for fancy points. Trap nests were kept for several breeds, and some tests to determine loss in dressing poultry were made. Bulletins of a popular nature on turkey raising and on the general management of poultry were prepared. No very definite experimental work was attempted.

The botanist conducted some nursery work in forestry and on shrubbery, with a view to determining the requirements of nursery work in forestry in Mississippi. No experimental work for the station was done.

The veterinary department reported some work with hog-cholera serum, for which the legislature made a special appropriation to the Live Stock Sanitary Board.

The publications of the station received during the year were as follows: Bulletins 121, Experiments in Feeding Beef Steers; 122, Report of the Work at the Holly Springs Station for 1908; 123, Inspection and Analyses of Commercial Feeding Stuffs on Sale in the State; 124, Pecan Culture; 125, Inspection and Analyses of Commercial Feeding Stuffs on Sale in the State; 126, Inspection and Analyses of Commercial Fertilizers on Sale in the State; 127, Inspection and Analyses of Cotton-seed Meal on Sale in Mississippi; 129, Sugar Cane for Sirup Making; 130, Peanuts; 131, Snap Beans; 132, Soils of Mississippi; 133, Inspection and Analyses of Commercial Feeding Stuffs on Sale in the State; 134, Broom Corn; 135, Cotton, 1909; 136, Feeding Beef Steers on Cotton-seed Meal, on Pasture; Circulars 20-26, Inspection and Analyses of Commercial Fertilizers on Sale in the State; and 30 and 31, Inspection and Analyses of Commercial Fertilizers on Sale on the State.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation for substations.....	16,425.00
Fees	90.00
Farm products	28,799.57
Miscellaneous	3,577.26
Total	76,891.83

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The year was one of many changes in personnel at the Mississippi station, but otherwise the conditions remained much the same as described in last year's report. It is hoped that the changes in the staff may result in strengthening the work of several departments and of the station as a whole.

MISSOURI.

Missouri Agricultural College Experiment Station, *Columbia.*

Department of the College of Agriculture and Mechanic Arts of the University of Missouri.

F. B. MUMFORD, B. S., *Director.*

The new agricultural building of the University of Missouri, which was dedicated December 28, 1909, contains the administrative offices of the dean and director, together with the station library, and further affords quarters for the departments of agronomy, animal husbandry, farm management, rural education, and the instructional work in agricultural chemistry. The offices of the State board of agriculture, the drug and food commission, the State veterinarian, and the State highway engineer are also located in this building. The construction of a veterinary hospital and hog-cholera serum laboratory was begun with State funds. A heating plant was built and the furnishing of the agricultural building was completed.

A project system was begun during the year which enables the director to keep more closely in touch with the various lines of work in progress than has heretofore been the case. The State appropriations for the biennium ending December 31, 1910, were enumerated in the last report, with the exceptions that appropriations of \$7,500 for outlying experiments, \$10,000 for the animal husbandry department, \$5,200 for the department of horticulture and botany, \$15,000 for the experiment station, and \$1,000 for the agricultural library were not mentioned.

The Adams-fund work of the station was continued, with additional equipment and an increase in the number of assistants. The results of the completion of certain phases of Adams-fund projects were reported during the year. The study of the influence of maturity on the yield of constituents of timothy, begun in 1908, was completed.

The results of the study of the dormant period in trees showed conclusively that the great majority of species indigenous to temperate climates do not have a firmly fixed winter resting period from

which they can not be awakened. The species most difficult to force were *Carya aquatica*, *C. porcina*, *Fagus sylvatica*, *Fraxinus americana*, *F. excelsior*, *F. ornus*, *Juglans regia*, *Liriodendron tulipifera*, *Quercus alba*, *Q. coccinea*, and *Q. olivæformis*. In connection with the investigations on the properties of milk it was ascertained that the cause of wide variation in milk production by dairy cows is the difference in the quantity of food they are able to consume and use above that required for maintenance. The work on the nutrition of steers was practically completed, and substantial progress was also made in the studies on the influence of age on the breeding powers of animals, the nutrition of heifers, nutrition of apple trees, and on hog cholera.

In addition to the Adams-fund investigations, numerous lines of work were carried on by the different departments of the station. The animal-husbandry department continued its pasture experiments with steers which have been going on for 15 years, studied winter rations for cattle, including the use of silage for fattening cattle, the influence of age and condition of cattle on economic efficiency, economic pork production and farm management, forage rations for hogs, and maintenance requirements for brood sows. The results of the study of specific effects of rations on the development of swine called attention to the importance of the ash constituents generally, and to phosphorus in particular, in the rations of growing animals.

In the horticultural department experiments were made in the home canning of fruits and vegetables, breeding asparagus, strawberries, tomatoes and other fruits and vegetables, methods of frost protection, comparison of apple stocks and scions, forcing vegetables, and methods of spraying. Peach trees pruned according to the methods advocated by the station were made to produce 2 additional crops in 8 years. Last year the Jonathan apple orchard on the horticultural grounds returned over \$300 per acre, while unsprayed Jonathan orchards in the neighborhood had almost no marketable fruit. As a demonstration experiment, the college last year sprayed 1 acre of Jonathan apples in a commercial apple orchard near Columbia and this sprayed acre produced more marketable apples than the remaining 139 acres which were not sprayed. In connection with the asparagus work it is reported that one-eighth acre of asparagus on the horticultural grounds has given an average return of \$80 annually for the past 5 years.

Forestry, which has heretofore been combined with horticulture as one department, was made a separate department during the year. Experiments with extensive plantings of catalpa and locust, especially in the Ozark region, are in progress.

The work in agronomy included rotation experiments in progress for 21 years, corn breeding with respect to yield, and composition

tests of varieties in breeding of wheat and oats, experiments with winter oats, barley, cowpeas, soy beans, alfalfa, and other forage plants, tests of methods of seeding, and studies in soil fertility. In 1 county of the State corn yields have been increased $16\frac{1}{2}$ bushels per acre and clover yields $1\frac{3}{4}$ tons on each acre by the application of results discovered by the station. Good soil management on one of the experiment fields increased the clover yield from one-half ton to 2 tons per acre, and the net profit by \$6. On the soil experiment fields in southwest Missouri the station has shown that corn may be increased from 20 to 45 bushels per acre. In the same locality the wheat yield has been increased 12 bushels per acre. In soil experiments carried on in northeast Missouri the yield of wheat was increased by 15 bushels per acre, with a corresponding increase in the net profit.

Experiments were made on the effect of high and low rations on butter-fat production, and experiments were begun on the transmission of tuberculosis from cattle to pigs. The college inoculated 40,000 hogs during the past year, 85 per cent of which were saved from hog cholera.

Fertilizer inspection and miscellaneous analyses were made by the chemical department.

The cooperative experiments of the station in 1910 were quite extensive. In 105 counties of the State 366 persons cooperated with the central station at Columbia in experiments to determine the best methods of farming. In carrying forward this work 3,000 different packages of seed were used and more than 20,000 pounds of fertilizer. Former students of the college of agriculture and farmers of the State have organized the Missouri Experiment Association, which has for its fundamental purpose cooperative investigations with the college and station. The results secured have already demonstrated that alfalfa can be grown successfully in every county of the State, and that the best varieties of corn from Missouri are Boone County White, Reid Yellow Dent, Johnson County White, and St. Charles White. The horticultural investigations have indicated the best fertilizers for orchard, bush fruits, and vegetables. Cooperators in dairying have, under the direction of the college and station, increased their profits, in some cases more than 20 per cent. Field experiments on typical soils of the State in cooperation with the soil survey were continued and extended, and are now conducted on fields in 96 of the 114 counties of the State. The soil survey was continued, partly in cooperation with the Bureau of Soils of this department.

Two additional county demonstration farms were organized during the year under the act of 1907, one at Clayton, St. Louis County, and the other near Lewiston in Lewis County, with E. L. Newton as superintendent. The chief lines of work undertaken at these

demonstration farms were the testing of corn, wheat, and oats with some attention to fertilizer and soil-fertility experiments.

An extension department was organized by the university which will also have charge of extension work of the college of agriculture. R. H. Emberson was appointed professor of rural education and has charge of the extension work for rural schools. During the year 5 men from the college of agriculture in 11 days' time gave instruction on agricultural topics to 28,000 people. This was accomplished by means of special trains furnished by 3 different railroads interested in the State. Instructors from the college and station also taught agriculture to 2,300 persons at special night schools in St. Louis and Kansas City. During the past year in the 114 counties of the State 460 addresses were made to 100,000 farmers in attendance.

A series of research bulletins to serve as a medium for the publication of the results of the more technical results of the station was begun during the year. Decided progress was made in the general publication work of the station.

The publications received from this station during the year were as follows: Bulletins 81, Specific Effects of Rations on the Development of Swine; 83, Soil Experiments on the Upland Loam of Southeast Missouri; 84, Soil Experiments on the Prairie Silt Loam of Southwest Missouri; 85, Inspection of Commercial Fertilizers; 86, Soil Experiments on the Rolling Limestone Upland of Southwest Missouri; Circulars of Information 31, Hardiness of Peach Buds, Blossoms, and Young Fruits as Influenced by the Care of the Orchard; 32, Missouri Apple Growing; 33, Hotbeds and Cold Frames—Their Preparation and Management; 34, Instructions for Spraying; 35, Protecting Orchards Against Frosts and Freezes; 36, Cooperative Experiments of the Department of Agronomy; 37, Variations in Cream Tests; and 38, The Principles of Maintaining Soil Fertility.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
Fees.....	10,580.20
Farm products.....	5,052.30
Miscellaneous.....	14.15
Total.....	43,646.65

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Missouri station is carrying on a large amount of carefully organized and well-managed work of fundamental importance to the agriculture of the State. With liberal State aid it is widely disseminating the practical results of this work.

MONTANA.

Montana Agricultural Experiment Station, Bozeman.

Department of the Montana College of Agriculture and Mechanic Arts.

F. B. LINFIELD, B. S. A., *Director*.

The Montana station continued to make steady progress during the year in its work and in the improvement of its equipment. The new sheep barn (Pl. II, fig. 2) and the new steer-feeding barn, for which the State appropriated \$10,000, were nearly completed during the year. The State appropriations for the year 1910-11 are as follows: Maintenance, \$12,000; dry-farm experiments, \$9,000; Fergus County substation, \$2,000; horticultural substation, \$1,250; and the donations for dry-farm work—Northern Pacific Railway, \$7,500; Chicago, Milwaukee & Puget Sound Railway, \$4,000; and the city of Helena, \$1,500. These appropriations did not include the grants of \$10,000 for buildings at the home station, \$5,000 for buildings and improvements at the Fergus County substation, and \$3,000 for buildings and equipment at the horticultural station made for the biennium 1909-1911.

The work at 2 permanent substations, 9 temporary dry-farming stations, and 3 horticultural substations is under the supervision of the director. During the year the governor of the State turned the Fort Ellis reserve of 640 acres over to the experiment station. This is a dry-farm tract with 300 acres plowed and the rest in pasture. About \$1,000 was invested in improvements on the place. This reserve is located near Bozeman, and the station has begun experimental work upon it.

Good progress was made in nearly all of the Adams-fund projects upon which the station is at work. The cement investigations have already been completed. The chemical change in the breaking down of cement when acted on by alkali has been determined and a bulletin on the results is in preparation. It was found that by the action of sodium sulphate the calcium hydrate or the binding material of cement was changed to calcium sulphate, which increased the volume of the substance and caused crumbling. The sodium hydrate set again, but was not as strong. As a remedy it is recommended that the cement be made less absorbent and more resistant to water, and for this purpose a 1 per cent soap solution was used, which gave an insoluble calcium stearate and palmate. The strength of natural cement was increased by using solutions of aluminum sulphate or soap solution in place of tap water in mixing up the cement.

The recent work on the incubation project was with reference to temperature, and additional equipment was provided for the more complete control and measurement of the conditions surrounding the eggs. Especial attention was given to the influence of temperature on the respiration of the chick and the development of carbon dioxid.

Studies on the life histories of sugar-beet insects were continued, and the army cutworm and other species of cutworms were included in the list. It was observed that the root louse could be kept out by keeping the land free from weeds in the early spring. A paper was published on the oyster-shell scale, but studies on the life history of this insect as well as on the parasites attacking it are continued.

In connection with the investigations on arsenic poisoning of fruit trees, the disease known as collar rot was studied. The effect of arsenic was observed by its application to clean, healthy roots of fruit trees, and the results indicated that under some conditions arsenic corroded the bark. Apparently arsenic spraying results in injury wherever the bark of the tree has been opened, while on older uninjured bark there is but little effect. The orchard-disease work was mainly upon apple canker, which is a Montana disease, black heart, and the collar rot in connection with the arsenic investigation.

The results in the soil-moisture project, as well as those in nitrate work, are ready for publication, although further work along these lines will be conducted. It appears that where the moisture content is good the nitrate formation is relatively high. In these studies it has been shown that the great benefit from summer fallow is due to the nitrates accumulated in the moist soil during the fallow season, which gives a rapid growth the following year, so that the crop usually has advanced beyond the stage of liability to serious injury before the dry period of the year arrives. The moisture studies were carried on under dry-farming conditions at the substation at Forsyth and on the Fort Ellis farm 3 miles east of the station. Moisture determinations are made every 10 days throughout the cropping season to a depth of 5 feet, and at the beginning and end of each season to a depth of 12 feet on plats handled under different rotations. The nitrate determinations are made on samples taken to a depth of 3 feet on the same plats every 20 days.

In the seepage projects 7 different soil types are under observation. These soils are placed in tanks and the movement of water through them is studied. In addition to this laboratory work the seepage on canals running through the different types of soil is studied during the growing season. It has been found that the governing factor in seepage is the nature of the soil, and that each particular soil type must be dealt with separately.

In the wool project a start was made with 20 pure-bred Rambouillet ewes. The variations in the wool were observed to be very wide. Tests were made of samples from different parts of the fleece to find the most representative part. In microscopical and histological studies of wool the diameter, crimple, luster, etc., are determined.

The various departments of the station also report progress during the year in the various lines of work conducted with the Hatch fund.

In the entomological department during the past season grasshoppers received considerable attention. Control methods by means of spraying and improvement in the spraying solutions used were worked out. The head of this department also worked on the spotted fever and its propagation, under a State appropriation as State entomologist and in cooperation with the Bureau of Entomology of this department.

The agronomy department has an area of 42 acres in experimental work. The variety tests conducted included 40 varieties of oats, 32 of spring wheat, 12 of peas, 40 of barley, and 28 of grasses, clovers, and crop mixtures. Rates of seeding ranging from $\frac{1}{2}$ to 4 bushels per acre were tested with wheat, oats, barley, and peas, and a study was made of the best time of seeding by commencing as early as the ground is in condition in the spring and continuing for 9 weeks with these same crops. A comparison of size in plats was made by growing grain planted under identical conditions on plats ranging from 0.01 to 0.25 acre in area. Rotation tests were made on 66 plats, and various mixtures of wheat, oats, barley, and peas were planted in duplicate, one set being cut for hay and the other for grain.

This department cooperates with the Bureau of Plant Industry of this department in dry-farming work and with this office in testing the efficiency of various mulches. In addition the department has charge of the work at the permanent dry-farming station at Moccasin, in Fergus County, and of twelve 40-acre tracts on which work of demonstration grade is in progress. These demonstration farms are held under 5-year leases, and the work is supported by the State and two of its important railroad lines.

In animal husbandry, experiments were made on the effects of different amounts of various grains fed with clover on the gain of steers. In pig feeding the effect of varying amounts of dry matter on the gain was studied, and the results were found less satisfactory with the more bulky feeds. A comparison of clover silage with clover hay as a feed for dairy cows was made during the past winter. Inbreeding work with hogs carried to the fifth generation indicated a loss in strength and fecundity.

The horticultural work was in charge of the new horticulturist who entered upon his duties at the beginning of the year. This department has about 5 acres of orchard at Bozeman and a substation of 20 acres in the Bitter Root Valley. The variety tests in progress were continued, and work was done on pruning tomatoes, cantaloup, squash, and watermelons to hasten maturity, on methods of irrigation of potatoes, etc. Tests were also in progress with varieties of apples and methods of culture and soil improvement.

The new veterinarian of the station took up work on contagious abortion.

The cooperative work of the station, as has already been mentioned, was largely confined to experiments carried on by different bureaus of this department and to dry-farming studies in different parts of the State. About 10 of the station officers gave from one to three weeks to farmers' institute work and to lectures on agriculture and related sciences at from one to four high schools in the State. Similar assistance was also given at the school of horticulture in Ravalli County and in connection with a demonstration train. The agronomy department gave considerable time to the work connected with the dry-farming congress which met at Billings.

The following publications were received from this station during the year: Bulletins 77, Fruit Tree Planting in Montana; 78, Steer Feeding; Circulars 1, Home Cheesemaking; 2, The Pear and Apple Blight in Montana; 3, Dry Farming Practice in Montana; and 4, The Army Cutworm.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation	32,990.48
Individuals	7,011.26
Farm products.....	6,384.34
Total.....	74,386.08

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Montana station is in a prosperous condition, and its course is marked by steady progress. The material equipment of the station is fairly complete, and an effort is made to use these facilities for the assistance of agriculture throughout the State, and particularly in certain sections where special problems present themselves. The attitude toward the station of the State, the railroads, the chambers of commerce, and the population in general is most encouraging and gratifying.

NEBRASKA.

Agricultural Experiment Station of Nebraska, Lincoln.

Department of the University of Nebraska.

E. A. BURNETT, B. S., *Director.*

Steady progress was made during the year at the Nebraska station in the development of well-established lines of work. A few changes were made in the organization and the personnel of the station.

L. W. Chase, of the department of agricultural engineering in the college of agriculture, was added to the station council as agricultural engineer, largely for the purpose of conducting experiments in farm drainage and sanitation and the use of cement for farm purposes. G. H. Coons, adjunct professor of agricultural botany, was appointed assistant in agricultural botany in the station, and toward the close of the year W. L. French, adjunct professor in dairy husbandry, was appointed assistant in dairy husbandry in the station.

Two new substations authorized by acts of the last legislature were located, one near Mitchell, in Scotts Bluff County, and the other near Valentine, in the sand hills region. For the station located at Mitchell, which is to give special attention to irrigation and dry-land work in agriculture, the State appropriated \$5,000 for the biennium ending April 11, and about \$2,000 of this sum was expended for permanent improvements. This station is conducted in cooperation with the Bureau of Plant Industry upon land furnished by the United States Reclamation Service. This department expends \$4,000 annually in connection with this work, and the Reclamation Service expended \$5,000 in the erection of buildings. Fritz Knorr, of the Bureau of Plant Industry, was appointed superintendent.

The Valentine substation, for which the State appropriated \$15,000 for the biennium, is to investigate the crops and agricultural methods adapted to the sand hills region of the State. Of the total appropriation about \$9,000 was used for improvements, including a dwelling and a barn, both constructed from concrete blocks. James Cowan was appointed superintendent of this substation. At the central station at Lincoln a steer-feeding plant to house 60 steers for experimental feeding purposes is in process of erection. The barn will be built of hollow brick, rough cast with cement, and will cost with equipment about \$10,000. The station at Lincoln expended during the year about \$17,500 of State funds, including \$5,500 appropriated for special purposes.

No new Adams-fund work was undertaken during the year, but the projects in hand were continued and certain phases of the investigations were completed. The work on the relation between leaf area and the use of water in corn was actively prosecuted and extended to include isolation of high-leaf and low-leaf strains of corn, transpiration at different periods and under different conditions of humidity of the air and soil, and evaporation from the soil under natural conditions. The results of these investigations indicated that the water required by the growing plant is proportional to the relative leaf area rather than to the relative dry weight. The loss of water by the plant was found to be correlated with the loss of water from a free surface, the plant apparently not exercising control in this case. The transpiration studies, together with field tests, indicated

that narrow-leaf types selected from Hogue Yellow Dent were more drought resistant than broad-leaf types. The strains with a high-leaf area yielded 43.6 bushels per acre, while those with a low-leaf area produced 52.1 bushels.

A report of progress was made on the investigation of the soils of the transition region, or the loess area of the State. In this connection changes in the composition of the loess soils of Nebraska caused by cultivation were studied, and it was concluded that with their chemical composition as a basis these soils are very fertile and are likely to maintain their productive capacity for a long time if they are kept in good physical condition, and are well supplied with nitrogen and organic matter.

Investigations relating to hyperimmunization and the possible use of a horse serum for hog cholera were continued during the year, and some observations were also made on the transmission of swamp fever by means of flies. The immunization of pigs in utero was studied in connection with hog-cholera work.

Considerable work was done on winter injury of fruit trees, and many pieces of apparatus were devised for these investigations. A large amount of data were also secured in the continuation of studies on heredity in plants. The plant-disease projects receiving attention during the year were a new *Fusarium* dry rot of potatoes, internal brown spotting of potatoes, and potato scab.

Work on the effect of close-breeding in maize and on thickness of stand on cereal plants was continued along the same line as heretofore. During this season, corn inbred the previous year decreased in yield by about 50 per cent as compared with the same corn either naturally fertilized or artificially crossed. This result may not have been due to inbreeding alone and several years of work are required before positive results will be obtained. In studying the effect of thickness of stand on cereal plants it was shown that when thick planting is practiced a certain percentage of plants are crowded out and fail to produce seed. Plants from strong, vigorous seed were more likely to survive, and plants from the small, shrunken seed more likely to be crowded out. With corn a higher yield was obtained under thick than under thin planting.

The investigations on the effect of feed on the strength of bones in pigs were continued with new combinations of feeds. Work was also begun on the study of the relation of type or conformation to gaining capacity in steers.

In addition to Adams-fund projects, extensive experiments were carried on, as in previous years, with field crops, more particularly in acclimatization and improvement in wheat, a special object being to increase the yield and extend the area of winter wheat in the State, improvement of varieties and methods of culture of corn, acclimatiza-

tion and improvement of oats, and adaptation of winter barley to Nebraska. The effect of crop rotation and continuous cropping on Nebraska soils was studied at the central station and at the North Platte substation. The best variety of corn for the silo in central and eastern Nebraska is also under investigation. Work was continued on the duty of water from the natural precipitation in crop production, the effect of fertilizers on Nebraska soils, the effect of soil inoculation for alfalfa, the value of sweet clover as a green manure, and the cost of producing crops in Nebraska.

Some experiments were also carried on in seed germination, on the influence of soil types on the root and form development of seedlings, the effect of spacing in plantations on the quality and quantity of growth of certain Nebraska trees, the effect of cutting back hardy catalpas at different ages as compared with seedling growth not cut back, and on methods of sowing seeds of various species of trees. Tests of varieties of potatoes and of the relative value of seeds from different regions were continued, demonstrating the superiority of seed grown locally under a straw mulch. Cooperative spraying demonstrations were continued with results showing the profitableness of the spraying of orchard fruits.

Experiments were carried on demonstrating the value of alfalfa in rations for fattening cattle. The dairy department continued records of the dairy herd begun 14 years ago and of calves from birth to maturity, compared beets and silage for cows, and dry feed versus pasture, studied the relation of conformation to performance in dairy animals in cooperation with five other stations, the time of maximum production in the lactation period, the effect of sires on daughters in breeding experiments, and the feeding of skim milk to calves.

The life history of a number of insect pests, including seed wheat Eleodes, the parasites of the white-marked tussock moth, melon aphid, squash borer, cucumber beetle, squash bug, pine-tip moth, corn-ear worm, potato-stalk borer, and strawberry-leaf roller, were studied during the year as well as methods for preventing their depredations. In all of the entomological work special attention was given to insect parasitism.

Work at the North Platte substation, as in previous years, included tests of varieties of cereals and forage plants adapted to dry-land conditions, crop rotations, studies of methods of conserving soil moisture, tests with forest trees, orchard fruits and ornamental plants, experiments in wintering cattle on different kinds of roughage, tests of grain for hogs, and the use of alfalfa for hay.

The station cooperated with this department in a number of lines of work, including breeding and selection of improved varieties of wheat, testing the milling and baking qualities of wheat, the maintenance of a seed laboratory, and testing of crops and methods of

culture suited to dry-land farming at North Platte. Cooperation with farmers is carried on extensively in a number of lines, including orchard-spraying demonstrations, tests of varieties of corn and small grains, experiments with fertilizers for grain, farm management, and forest plantings. Some of the station men assisted during the year in farmers' institutes held in different parts of the State.

The publications received from this station during the year were as follows: Bulletins 110, Report of the Nebraska Seed Laboratory; 111, Changes in the Composition of the Loess Soils of Nebraska Caused by Cultivation; 112, Experiments with Corn; 113, Oats; 114, Storing Moisture in the Soil; Circular 1, Cooperative Experiments in Forest Planting; and Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation, central station, amount used estimated.....	17,500.00
State appropriation, amount used for North Platte substation.....	24,994.93
Farm products	28,511.73
Balance from previous year.....	2,345.75
Total.....	101,352.41

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The work of the Nebraska station was broadened and strengthened during the year, and the institution extended its operations and its influence throughout the State by means of cooperative experiments and by the establishment of substations made possible by liberal State aid.

NEVADA.

Nevada Agricultural Experiment Station, *Reno*.

Department of Nevada State University.

J. E. STUBBS, D. D., LL. D., *Director*.

Few changes occurred on the staff of the Nevada station, the principal ones being the transfer of S. C. Dinsmore, the former station chemist, to the food and drugs inspection work, and the appointment of Dr. C. A. Jacobson as research chemist for the station early in the year. The farm for dry-farming experiments, for which the State made a maintenance appropriation, was purchased and donated by Elko County at a cost of about \$2,000. Possession was secured in June, and the work of clearing off the sagebrush and of breaking the land was begun. The conditions on this farm are favorable for dry farming, which has been practiced very little in that section. It is

typical of large tracts of land in the valley in which it is located. The new food and drugs act, with its supervision and enforcement in the hands of the station, went into effect January 1, 1910. A special building for the station library was erected during the year at a cost of about \$1,200, an animal house was built for the use of the department of biology, and one wing of a new greenhouse was erected at a cost of approximately \$5,000.

P. B. Kennedy, the station botanist, continued to act as chairman of the board of control of the Lincoln County experiment farm. A report on the operations of this farm for the biennial period ended December 31, 1910, is in course of preparation.

In the Adams-fund work on the genus *Trifolium*, with special reference to the economic value of native species, seeds of 47 species were secured and cultivated with many others for comparison. All but one of the 47 species were native, and some of them from the sagebrush land are very dry and tough, and the hairy ones are very drought resistant. The species were worked out as they were found in different localities, and the life habits and their method of propagation were studied. *Trifolium majus*, a native species ordinarily collected in California, attains a very dense growth, with spreading stem 2 to 3 feet high, and bears an abundance of seed. *T. variegatum* is of low but dense growth and *T. wormskejdii* has been found to be an exceedingly vigorous plant, growing thick masses and spreading readily by underground stems. The value of the different species for forage purposes as well as for ornamental planting was studied.

In following up the alfalfa-breeding project, it was found that when the plants grew too closely they failed to produce seed. The research chemist studied the relation of nitrogen to the organic constituents of the alfalfa plant and isolated certain of these constituents. Two distinct nitrogenous substances were isolated, which will be studied in relation to different stages of growth and the stage at which the largest amount is present. In connection with the poisonous-plant investigations, work was started on the water hemlock and special attention was given to the chemical constituents of different parts of the plant with a view to determining and isolating the active principle.

The meteorological and climatological studies on Mount Rose were largely confined to the conservation of snow. Snow was measured with a specially devised sampler under various conditions of slope, compass position, and protection by timber; its density when it first falls, the increase in density, etc. It was found that the character of the forest exerts considerable influence in this connection, and a study of the best conditions for snow conservation was begun. The temperature of snow at different depths was measured, as was also the evaporation of snow due to high winds.

Some work was done on the entomological projects, especially on the parasitic and predaceous enemies of the codling moth. Work was also continued on the study of anemia in horses, the pathological anatomy being worked out. Inoculation experiments carried on in this connection gave varying results, and hence the infectious character was not established beyond question.

Under the Hatch fund, progress was made in various lines of work. The station herbarium now numbers 11,190 specimens, and is used largely in advising ranchmen about the native plants. Experiments in smudging to prevent frost injury indicate that fruit can be successfully grown even in the low-lying valleys where conditions are very adverse to the production of a crop. A number of ornamental shrubs grown in the arboretum have been found well suited to the climatic conditions of the State.

The chemist did considerable miscellaneous analytical work on soils, water, feeds, etc. A report was made on digestion experiments conducted on the range, and it was found quite feasible to determine approximately the feeding value of the various plants under range conditions. Soils from Las Vegas containing 15 per cent of gypsum were examined, and pot experiments were made which indicated the unproductiveness of the soil to be due to the gypsum it contained. In agriculture and animal husbandry sheep breeding for early lambs was carried on, oats and peas were grown for pig fattening, and some work was done in the methods of irrigating and cultivating alfalfa, including the selection of varieties for drought resistance and for pasturing. Variety tests were made of sugar beets, Kafir corn, winter wheat, and similar crops; and evaporation studies were made in tanks in which the soil was cultivated to depths of 2, 4, and 6 inches. The effect of time of application of irrigation water on oats and wheat and the number of applications before and after heading were studied in relation to softness of the grain. Breeding work with potatoes was followed, and the study of the effect of proper cultivation and of irrigation was included. Tests were made of various plants grown for forage and for pasturage, and a dairy herd of 8 cows was secured for the purpose of studying the cost of butter-fat production with different feeds.

The entomologist studied the alfalfa cutworm and tested the use of irrigation water run down the furrows at night when the worms are out as a means of their control. Means of stamping out the Mediterranean flour moth were tested in a local flour mill, an unidentified parasite of the insect was studied, and the investigation on the European elm scale was followed up.

The following publications were received from this station during the year: Bulletins 68, Equine Anemia; 69, A Report on Irrigation Laws and Litigation in Nevada; 70 Food and Drug Inspection; 71,

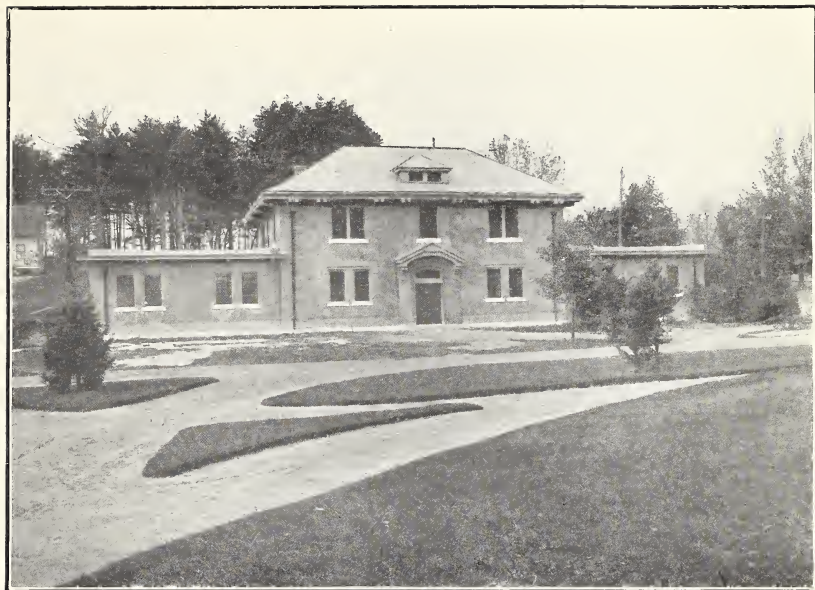


FIG. 1.—NEW DAIRY BUILDING, NEW HAMPSHIRE COLLEGE AND STATION.



FIG. 2.—SHEEP BARN AT THE NEW HAMPSHIRE STATION.

Digestion Experiments on the Range; Circulars 1, Glanders; 2, Ice Cream; 3, Flavoring Extracts and Soda Fountain Sirups; 4, Coloring Matter in Food Products; 5, Inspection of Nursery Stock; 6, Spraying Trees for the Elm Scale; 7, Labeling of Food Products Artificially Colored; and the Report of Lincoln County Experiment Farm, 1907-8.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
Farm products	2,945.23
Miscellaneous.....	7.33
Balance from previous year.....	610.68
Total	31,563.24

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The interest in the work of the Nevada station is increasing in proportion to the growth of agriculture within the State. The station has a good field and is at work on problems important to the development of agriculture in its region.

NEW HAMPSHIRE.

New Hampshire College Agricultural Experiment Station, *Durham*.

Department of New Hampshire College of Agriculture and Mechanic Arts.

J. C. KENDALL, B. S., *Director*.

Several important changes occurred at the New Hampshire station during the year. The resignation of the directorship by E. D. Sanderson took effect January 1, 1910, when the president of the college assumed the duties of the office pending the appointment of a new director. E. D. Sanderson retained the position of station entomologist until the close of the year, when he was succeeded by W. C. O'Kane. A number of changes also took place in the corps of station assistants. After the close of the fiscal year J. C. Kendall from the Kansas station was appointed director, entering upon his duties in September, 1910.

During the year the dairy stables were remodeled at a cost of \$3,000, and a new sheep barn for use in the sheep feeding and breeding experiments and a new dairy building were constructed. (Pl. III.)

Progress in all the Adams-fund investigations was reported. The sheep-breeding work, pursued to discover the inheritance of characters as based on Mendel's law, reached the F_1 generation, and

preparations for breeding the F_2 generation were made. Hampshire, Southdown, Shropshire, Dorset Horn, Leicester, and Rambouillet sheep are used in this work, and an elaborate series of measurements and records taken. It is claimed that already the manner of inheritance of many characters can be distinguished and the result from such crosses predicted. A study was made of the different crosses with regard to their adaptability to the production of early lambs. Coincidentally the inheritance of the characters of twin bearing and multinipples was taken up for investigation. Another line of observation taken up during the year in connection with this project was the determination of postnatal variation in the growth of sheep and in the growth of large bones of the extremities. Dr. C. B. Davenport, of the Station of Experimental Evolution, Carnegie Institution, is a collaborator in this research in sheep breeding.

Results obtained this season in the fruit-bud formation project showed that the rate of wood growth in plats cultivated every other year was approximately double that of plats not cultivated, and in plats cultivated every year the rate of wood growth was double that of plats cultivated every other year. No marked differences appeared in rate of wood growth between unfertilized cultivated plats and fertilized cultivated plats. Together with cultivation, the presence of certain fertilizers, often in excess of normal amounts, seemed to stimulate the formation of fruit buds. Plant-breeding work was continued with squashes, watermelons, and carnations, and studies of correlations in the strawberry were again pursued. In the experiments with carnations pure types were sought, and valuable and useful variations were looked for. During the past season pure color types were isolated and crosses made between them for the purpose of determining Mendelian proportions. One valuable new crimson carnation was discovered in connection with this work, and its propagation was begun. The correlation studies on the strawberry included the records on the fruit and foliage of 931 seedling plants. Measurements of the leaves were made in order to determine whether correlations exist between the size of leaves and the size of fruits, and the total amount of foliage and the total amount of fruit.

Considerable advance was reported in working out the life history of the fruit-spot diseases of apples. The effects of temperature and moisture upon the fruit-spot of apples in storage were studied, and observations were made on the leaf spots, three species of *Sphaeropsis* being studied. Inoculation and spraying experiments were made to determine the time that leaf-spot infection takes place, and the results indicated that there is but little spread of the disease after June 10, but that on water sprouts and other tender growths infection may

occur throughout July. It was further found that a large-spored species of *Sphaeropsis* was much more vigorous in producing leaf-spot and was also more common on cankers than a small-spored species under investigation.

The study of the physiological disease known as the point rot of the tomato was entered upon as a new project. Experiments on heavy and light watering of tomato plants in relation to the occurrence of this disease showed that poorly watered plants were a little more susceptible to the disease than others, but not sufficiently so to indicate that drought is the cause of the malady. Apparently an excess of horse manure in the soil may favor the disease.

In the department of entomology, the project on the relation of temperature to the transformations and mortality of insects was practically concluded and the work was discontinued. Considerable progress was made on the better understanding of the factors of temperature and moisture on insect life. In connection with the apple-maggot project, attempts were made to determine the length of time that the larvæ remain in dropped apples before pupating, this fact having an important bearing on the control of the pest. Poisoning the adult flies with sweetened arsenicals before egg laying gave some valuable results.

The results secured in the project on the availability of potash in strong clay soils were published in part in Bulletin 142 of the station. The indications are that for the heavy clay soils of the State, as shown by the water-soluble potash present, the amount of potash in the crop, and the amount of soil water required to produce the crop, potash fertilizers are not essential for the production of good crops of clover and grasses. This same line of work was extended to some of the lighter soils, and experiments were also begun to determine the effect of tillage on soil potash.

With Hatch funds the department of agronomy carried on variety and fertilizer tests with corn, and experiments with alfalfa, together with meadow and pasture improvement work. This was the fourth season the improvement of Minnesota No. 13 corn was continued, and the results so far indicate that early maturity can be induced, the yield increased, and dent corn kept from assuming the characteristics of the flint type by isolating it from flint varieties. In the fertilizer experiment on grass land begun in 1907, the average yield this season without fertilizer was 1.896 tons of hay per acre, while the heaviest yield, 3.41 tons, was secured with 400 pounds of nitrate of soda, and the lowest yield, 1.62 tons, with 600 tons of land plaster per acre. An alfalfa plat seeded in July, 1909, yielded this year in 3 cuttings a total of 3.45 tons of hay per acre. On another plat different rates of liming and seed inoculation were tested. An alfalfa nursery for

testing seed from different sources as well as individual plants was started this year. In a pasture improvement experiment begun in 1909, various treatments such as harrowing, reseeding, fertilizing, liming, plowing, and sheep pasturing were tried.

The horticulturist continued variety tests of plums, apples, and lettuce. The work with apples included the renovation of an orchard formerly in sod by bringing the land into good tilth. Fertilizer tests with lettuce were made in the greenhouse and the value of Romaine and head lettuce for greenhouse culture was compared. The preparation of a monograph on varieties of lettuce was continued; and the influence of different top-dressings in growing carnations on raised benches in greenhouses with reference to the keeping quality of the flowers were studied.

In animal husbandry, the results of feeding experiments with sheep showed that the use of clover hay produced greater and cheaper gains than the hay mixture ordinarily fed in the State; that turnips fed with grain and hay appreciably reduced the cost of mutton production; and that silage was not as valuable as turnips as a feed for sheep.

The entomologist demonstrated the possibility of controlling the black fly in the White Mountains by treating streams where these flies breed with a suitable soluble oil which kills the larvæ without injury to the trout in the stream. Studies were also made of leaf hoppers, blister mites, and other insects.

The station carries on cooperative experiments with farmers in the hay-land improvement work, and with this department in testing 25 strains of soy beans with reference to period of maturity, yielding capacity, habits of growth, and general adaptability. The study of the nutritive ratio of corn and soy-bean silage mixed in the proportion of 2:1, as compared with pure corn and pure bean silage, was also pursued cooperatively. Part of the station work on soil potash is in a measure cooperative with farmers. The station made examinations of 238 samples of grass and grain seed and analyses of 135 samples of feeds and 140 samples of fertilizers for the State board of agriculture.

The following publications were received from this station during the year: Bulletins 141, A Study of Farm Buttermaking in New Hampshire; 142, The Availability of the Soil Potash in Clay and Clay Loam Soils; 143, The Codling Moth and How to Control It by Spraying; 144, Some Apple Diseases; 145, Variety Tests of Oats, Barley, Wheat, and Rye; 146, Analyses of Fertilizers; 147, Analyses of Feeding Stuffs; Circular 7, Some Essentials in Farm Buttermaking; Scientific Contributions 3, The Oblique Banded Leaf Roller—A New Insectary; 4, The Relation of Temperature to the Growth of Insects; and the Annual Report, 1907-8.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$14, 250. 00
United States appropriation, Adams Act.....	13, 000. 00
Balance from United States appropriations for 1908-9..	750. 00
Miscellaneous	3, 873. 37
Total.....	31, 873. 37

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

A special need of this station is the opportunity to place its work before the people of the State through demonstration and cooperative experiments and other extension enterprises. The amount which can be done in this direction with the Federal funds is quite restricted, and a small appropriation is needed for the purpose.

NEW JERSEY.

New Jersey State Agricultural Experiment Station, *New Brunswick.*

At Rutgers College.

E. B. VOORHEES, D. Sc., *Director.*

New Jersey Agricultural College Experiment Station, *New Brunswick.*

Department of Rutgers College.

E. B. VOORHEES, D. Sc., *Director.*

No changes were made during the year in the important lines of work and in the station staff. The provision of new equipment was limited to the construction of a laboratory, costing with furnishings about \$1,000, and designed for the use of the biologist in the work on oysters. For entomological investigations, including the mosquito work, the State allows from \$20,000 to \$25,000 annually.

As heretofore, the Adams-fund investigations were confined to studies in chemistry and bacteriology of soils and to plant breeding. Under the soils project the associative growth of leguminous and non-leguminous plants was studied, and a preliminary paper on the subject was published. The efficiency of commercial cultures of *Pseudomonas radicola* for inoculating purposes was studied, the results, as recorded in Bulletin 227 of the station, showing that on soils properly drained and properly supplied with moisture, lime, phosphates, and potash the commercial cultures under test were capable of increasing the yields of such leguminous crops as had not been previously grown on the land.

The bacterial factor of barnyard manure was studied to ascertain in how far the beneficial effects from it are due to its action as an inoculating material and how far to the plant food it supplies.

Experiments were also conducted with green manures, and with ferrous sulphate and gypsum, as to their influence on the bacterial flora of the soil.

An attempt is being made to develop a bacteriological method for determining the availability of nitrogen in organic nitrogenous fertilizers. Crops are grown in pots fertilized with different nitrogenous fertilizers, and the amount of nitrogen taken up is determined (Pl. IV, fig. 1). In the check tests in the laboratory definite quantities of nitrogenous fertilizers are inoculated with pure cultures of bacteria or soil infusion and the ammonia distilled off in a few days. The results are very promising. The specific effect of nitrogenous, phosphatic, and potash fertilizers, as evidenced by the kind of weeds which flourished where they were applied, was also studied. Laboratory study on *Azotobacter* was continued, three new species of nitrogen-fixing organisms having been isolated.

In the plant-breeding project attention was primarily directed toward studying the principles of inheritance in beans, sweet corn, eggplants, peppers, squashes, and tomatoes. As a foundation for the study of inheritance in breeding tomatoes a thorough study was made of the skins of the various types of tomatoes, and the results were published in Bulletin 228. About 120 reciprocal crosses of the different types of tomatoes have been made, and in the leading types the first generation crosses were studied in detail with reference to cotyledons and the first and the normal leaf. Attention was also given to heredity in size and type of fruit, cell structure of fruit, leaf, and stem, and to other characters. A large amount of similar work was carried on with peppers. Breeding work with sweet corn was carried on with the object of increasing depth of kernel. In conjunction with this project the study of the effect of environmental factors such as heat, light, moisture, etc., on variation in plants was also taken up. In this work, in order to eliminate the factor of individuality, plants as closely related as possible were used. In some cases plants were sprouted from the leaves, and those from the same leaf were separated to receive different treatment.

Under the Hatch fund the horticulturist studied the effect of cover crops in a dwarf apple orchard, and continued the work with grapes at Vineland and with peaches at High Bridge. Green-manuring work in these orchards and greenhouse experiments with carnations on the influence of the mechanical condition of the soil to determine whether a substitution of commercial fertilizers may be made for a part of the manure used were carried on in cooperation with the soil bacteriologist. Some fertilizer work with roses was also conducted in the greenhouse.

The station alfalfa field of 10 acres seeded last year produced 60 tons of hay in $3\frac{1}{2}$ cuttings. There has been a great growth of interest



FIG. 1.—EXPERIMENTS ON THE ACCUMULATION AND UTILIZATION OF ATMOSPHERIC NITROGEN, NEW JERSEY STATIONS.

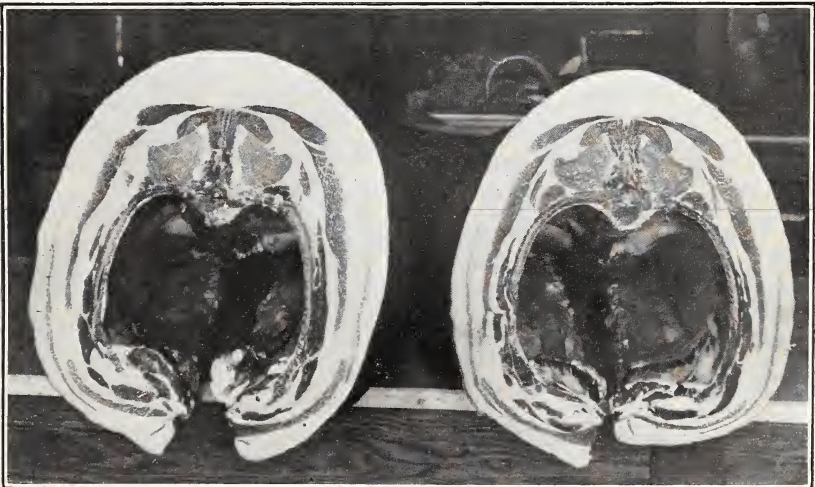


FIG. 2.—FEEDING EXPERIMENTS WITH HOGS, NORTH DAKOTA STATION. (*a*) CORN FED CARCASS, AND (*b*) BARLEY FED CARCASS OF LITTER MATES.

in this crop within the State, and this fact is regarded as mainly due to the station work with it.

The work of the biologist was confined to the subject of oyster culture, and related in particular to a study of the influence of meteorological factors on spawning and spatting, and the effect of "floating" oysters in water of less saline content than that in which they were grown. It was ascertained that though oysters spawned abundantly at different times during the summer, only the spawn ejected in June effected a set of spat or seed, and that this was less abundant than normally on account of the cold weather of May and early June.

The expenses of the investigation of "floating" were borne in part by the Oystermen's Association and in part by the State Bureau of Shell Fisheries.

The entomological work of the station covered investigations on insects injurious to strawberries and sweet potatoes in New Jersey, on root maggots and on insecticides not yet tested out, such as sulphate of nicotin, arsenate of iron, dry arsenate of lead, lime-sulphur, and oils in combination and the like. Results published in Bulletin 225 with reference to insects injurious to strawberries show that the injury of these insects may be limited by certain practices with a minimum resort to insecticide applications, while the results in Bulletin 229 show that it was possible to avoid practically all insect injury to sweet potatoes by proper early practice with little resort to insecticides.

The entomological department of the station cooperates with the State entomologist in the inspection of imported nursery stock. Co-operative work is also carried on with farmers in the comparative testing of insecticides under different conditions and in studying the effect of farm practice on the development of insects and chiefly of the underground species.

The following publications were received from this station during the year: Bulletins 220, Concentrated Feeding Stuffs; 221, Investigations Relative to the use of Nitrogenous Materials, 1898-1907; 222, Analyses of Paris Green and Lead Arsenate; 223, Analyses and Valuations of Commercial Fertilizers—Analyses of Fertilizer Supplies, Home Mixtures, and Special Compounds; 224, Analyses and Valuations of Commercial Fertilizers and Ground Bone—The Cost of Available Nitrogen; 225, Insects Injurious to Strawberries; 226, Peach Yellows and Little Peach; 227, Tests of Commercial Cultures for Soil Inoculation; 229, Insects Injurious to Sweet Potatoes in New Jersey; 230, Concentrated Feeding Stuffs; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

State Station: State appropriation (fiscal year ended	
Oct. 31, 1910)-----	\$39,000
College Station:	
United States appropriation, Hatch Act-----	15,000
United States appropriation, Adams Act-----	13,000
Total-----	67,000

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The work of the New Jersey stations is going forward in an orderly and systematic way, and is accomplishing a great deal for the agriculture of the State.

NEW MEXICO.

Agricultural Experiment Station of New Mexico, Agricultural College.

Department of New Mexico College of Agriculture and Mechanic Arts.

LUTHER FOSTER, M. S. A., *Director.*

Unlike the previous year, the changes on the staff of the New Mexico station were comparatively few and were confined to the minor positions.

The Adams-fund work of the year in horticulture consisted of the continuation of the plant-breeding experiments with Mexican chillies, investigations on the grape crown gall, life-history studies of the codling moth under New Mexican conditions, and experiments to ascertain why potato tubers failed to develop properly in parts of the Territory. In connection with the breeding work on chillies, 11 strains were grown in plat tests for comparison, and work on the potato project was pursued in the field and in the greenhouse.

In the work on sugars in cactus fruits, special attention was given to the relation of development of sugars to ripening of the fruit, the use of the mucilage contained in the plant for paper sizing, and the coloring matter of the fruit with reference to its commercial use. Work was also done on the production of alcohol from tunas, the results of which were published in Bulletin 72 of the station.

In connection with the project on the relations of soil, water, and crop in respect to irrigation, different amounts of water were applied to different crops, and soil moisture, temperature, and evaporation were measured and recorded. This work was supplemented by transpiration experiments carried on in tanks. This year corn was grown in the rotation, and the crops produced with irrigations of 1 and 2 inches at frequent intervals did not grow so well as those receiving 3 and 4 inch irrigations at more remote intervals. The results of the

year brought out the necessity of establishing a standard for comparison of moisture other than the dry-basis percentage. The investigation of the differences in performance and the sources and reasons for energy loss in different types of pumps for irrigation purposes was brought to a close, and the results were prepared for publication.

With Hatch funds, the horticulturist, in cooperation with this department, recorded phenological data on peaches and grapes, studied sun scald as related to methods of pruning, whitewashing, and other treatments, and tested spring and fall or winter pruning of grapes. A 2-acre apple orchard of 48 varieties has been started on land with 4 to 5 feet of sandy soil and a good subsoil, for the purpose of studying the effect of woolly aphis on trees grown on this soil where the roots are relatively long. A test was made of apple grafts on pear stock. The resistance of peach buds to frost was observed, and the use of smudge pots to prevent frost injury was tried. The peach was apparently more susceptible to frost injury when it had dropped the petals and the fruit was about the size of a pea. Data were also collected on the cost of production, yield, and returns in peach culture. With onions, culture and variety tests were continued, and the results published in a bulletin indicate that good onion seed can be grown in that section. Observations were also made on sweet potatoes, celery, and cabbage.

The work in agronomy included variety and culture tests, breeding experiments, and fertilizer trials with wheat, barley, rye, oats, corn, sorghum, alfalfa, clover, and miscellaneous forage crops. Rotation experiments were continued, and tests were made with plows for working adobe soils and with haying machinery. Fall seeding of spring wheat did not seem to affect the maturing of the crop, and in general there was no decided difference due to time of seeding from October 15 to February 15. A test of 17 varieties resulted in yields ranging from 29 to 67½ bushels per acre. A short-staple and a long-staple Upland variety of cotton under test fruited very heavily, and although late in opening indicated good yields. Giant and Dwarf broom corn produced good brush and Texas-Seeded Ribbon cane made a fair growth. In the fertilizer work, attention was given to the use of excessively heavy fertilizer applications to study the effects of commercial and natural manures on the growth of crops and the production of alkali. Red clover made a good growth, but was not as satisfactory as alfalfa.

The chemist completed the study of the wax from the candelilla plant, and determined its relation to beeswax, carnauba, and other waxes. Time was further devoted to the study of a method for the separation of iron, alumina, and phosphoric acid in inorganic plant constituents, and to the compilation of water analyses made from

different counties of the Territory during the past 10 years. In cooperation with the Reclamation Service the changes in irrigation water taken from the Pecos River at Carlsbad during the irrigating season were determined, and in cooperation with the State engineer waters of different localities were examined.

In animal husbandry, feeding experiments were conducted with 10 dairy cows in which grass pasturage alone was compared with grass supplemented with corn meal and bran. A feeding experiment with 25 yearling range steers was continued, the results showing that the cheapest gain resulted from feeding alfalfa alone, and that light grain feeding during the last 30 days of the feeding period was more profitable than feeding grain the entire period. The results of a pig-feeding experiment indicated that alfalfa pasture alone is not a satisfactory means of fattening growing pigs, and that the largest returns per acre for alfalfa pasture were secured in connection with a half-grain ration or with feeding skimmed milk. It was further found that 8 pounds of skimmed milk was practically equivalent to 1 pound of wheat as a supplement to alfalfa pasture. With poultry, incubator experiments were made to study the variation of moisture conditions in high altitudes, the means by which the moisture might be increased in the machine, and the cause of mortality of chicks in the shell.

A dry farm is conducted at Tucumcari with a territorial appropriation of \$5,000 a year for two years. Several small buildings were put up and the land is under cultivation. This farm is under a different board of management and has but little, if any, connection with the station.

The following publications were received from this station during the year: Bulletins 70, Sweet Potato Culture; 71, The Small Irrigation Pumping Plant; 72, Denatured Alcohol from Tunas and other Sources; 73, Tests of Pumping Plants in New Mexico, 1908-9; 74, Onion Tests, 1905-1909; and 75, Apple Culture under Irrigation.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	13, 000. 00
Farm products	2, 208. 19
Fees	1, 496. 07
Total.....	31, 704. 26

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The work of the New Mexico station includes the study of numerous problems which present themselves in different sections and

which vary with the conditions. The interest in the station grows with the efficiency with which these questions are solved and the adaptability of the solutions to actual practice.

NEW YORK.

New York Agricultural Experiment Station, *Geneva*.

W. H. JORDAN, D. Sc., *Director*.

At the last session the legislature appropriated about \$122,000 for the maintenance of the station. No marked changes in funds, buildings, staff, or equipment occurred during the fiscal year ended June 30, 1910.

Work on both of the Adams-fund projects noted in the last report was continued along the prescribed lines. The study of the function and importance of phytin in animal nutrition was conducted under the project relating to the metabolism and physiological effect of certain ash compounds fed to animals. Goats were used for these experiments. In connection with this study calcium, potassium, and magnesium compounds of phytin were made for use in the investigation. Several series of results have already been obtained with these salts when fed to goats. Satisfactory progress was also made in the bacteriological and chemical studies of cheese ripening which were conducted cooperatively between the departments of bacteriology and chemistry. This investigation included a study of casein and paracasein, as well as bacteriological studies on the changes of milk. The effect of bacteria on the products of paracasein was also investigated.

The greater portion of the station's work was maintained by State funds. The chemical department continued work on milk and cheese, principally on sour milk, koumiss, the ash constituents of cheese, etc.; tested methods of determining potash in fertilizers; investigated the acidity of gluten feeds, and made a chemical study of lime and sulphur preparations, and of fermentation changes of citrates in milk. A method was worked out for preparing a lime-sulphur mixture, utilizing sulphur and lime with the least waste of material and with the production of a solution having a maximum content of calcium pentasulphid.

The entomological department conducted studies of apple and pear tree hoppers, cabbage maggots, tree crickets, ermine moths, and maple-gall mites, together with tests of control methods. Spraying with kerosene emulsion early in May, followed in about two weeks with a second application, was found an efficient method of controlling the pear psylla. Tobacco preparations combined with some standard fungicide were found quite efficient against the psylla

and also protected against diseases. The pink aphid required stronger solutions than the pear psylla. Contact insecticides had little effect on the eggs of the aphid, while rather strong lime-sulphur mixture destroyed the eggs of the psylla. Life-history studies of several insects were made and work on a monograph of the maple-gall mites, the Eriophyidae, progressed.

The bacteriological department cooperated with the chemical department on the cheese project, studied the various factors entering into the production of sanitary milk, and investigated various bacterial diseases of plants. Laboratory and field studies were made on the soft-rot organisms to determine their pathogenicity, on seed-borne bacterial diseases, etc. In the study of sanitary milk production, the factors controlling the production of clean milk when using the milking machine were differentiated, and the best form of milking pail for use in hand milking was determined by a careful series of tests.

In the department of botany the 10-year potato spraying experiment was continued, this being the ninth year. Studies were made of currant diseases and cane blight of bush fruits, cabbage diseases, various obscure diseases of crops where no specific organism is present, etc. Progress was made in the study of grape diseases in the Chautauqua district and other important grape-producing regions of the State. In addition to the disease work, investigations were made with reference to varieties, methods of culture, and grape insects. Considerable work was carried on in seed testing and spraying tests for the eradication of dandelions in lawns.

The department of horticulture carried on a large amount of variety testing, plant breeding, and cooperative experimentation. In studying the relative value of Doucin, Paradise, and Standard stocks for varieties of apples, it was found that the Standard stocks are best adapted to New York conditions. Comparisons were made of various fertilizers for orchards, and experiments were carried on with reference to management of vineyards, including work in pruning, cultivation, fertilizers, cover crops, etc. A monograph by the department on the plums of New York was about completed.

Among a number of miscellaneous investigations may be cited studies on the cost of production of goat's milk and its value for invalids and others. The station also does a large amount of inspection work, including analyses of fertilizers, feeding stuffs, agricultural lime, insecticides and fungicides, and also tested the glassware used in factories and milk-receiving stations where the Babcock test is employed.

The dairy expert, among other lines of endeavor, worked in cooperation with the bacteriological department on the problem of producing sanitary milk, and also continued the test of the station

herd. In trials conducted with the milking machine it was found that the quality of milk depends primarily upon care in use of the machine. Immersion of the milking parts of the machine in a 10 per cent solution of common salt between milkings was found more efficacious than steaming. The germ content was found to be determined largely by the efficiency of the air filters. In a bulletin published during the year the profits secured from the best and poorest individuals of the station herd are pointed out and the necessity of retaining only the best cows for the highest profits is discussed.

The cooperative work of the station includes a study of nitrogen-assimilating organisms in cooperation with the Central Experimental Farm and MacDonald College of Canada and with the Bureau of Plant Industry of this department, potato-spraying experiments and potato-fertilizer tests in cooperation with farmers, experiments on the control of currant diseases, cooperation with fruit growers in the use of homemade concentrated lime-sulphur solutions, and cooperation with the Bureau of Entomology of this department in the control of the Hessian fly.

The extension work of the station consisted mainly in two weeks' work each by heads of departments and six assistants at farmers' institutes.

The following publications were received from this station during the year: Bulletins 316, Inspection of Feeding Stuffs (with popular edition); 317, Milking Machines: Effect of Method of Handling on the Germ Content of Milk (with popular edition); 318, Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1909; 319, A Chemical Study of the Lime-sulphur Wash (with popular edition); 320, Concentrated Lime-sulphur Mixtures (with popular edition); 321, Director's Report, 1909; 322, The Individual Animal as the Unit in Profitable Dairying (with popular edition); Technical Bulletins 10, The Volumetric Method for the Determination of Casein in Milk; 11, The Bacterial Soft Rots of Certain Vegetables; and 12, Crown Rot, Arsenical Poisoning, and Winter Injury.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$1,500.00
United States appropriation, Adams Act.....	1,300.00
State appropriation	98,243.85
Balance from previous year.....	3,085.93
Total.....	104,129.83

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The New York Experiment Station enjoys a condition of prosperity, has all its work well planned, and exhibits a condition of harmony and cooperation among the workers on its staff which mean much in promoting its efficiency.

Cornell University Agricultural Experiment Station, Ithaca.

Department of New York State College of Agriculture at Cornell University.

L. H. BAILEY, M. S., LL. D., *Director.*

At the Cornell station the year was marked by development in equipment and progress in experimental work. During the year the new greenhouses (Pl. V, fig. 1) and the new barns (Pl. V, fig. 2) were completed and are now in use. The barns are for station use so far as experiments in poultry and feeding are concerned. The legislature at its last session made provision for the erection of a general classroom, laboratory, and auditorium building to cost \$113,000; a poultry building to cost \$90,000; and a home economics building to cost \$154,000. In addition a central heating plant, to cost about \$50,000, is to be supplied when these buildings have progressed far enough to require it. The completion of these structures, in addition to greatly relieving the crowded condition of the college of agriculture, will furnish more space for the work of the experiment station. Three industrial fellowships were established during the year, making now a total of four for the investigation of plant diseases. H. J. Webber served as acting dean and director while L. H. Bailey was on leave of absence. The changes on the station staff were few and were confined to minor positions.

The Adams Act investigations were continued on the projects in hand. The breeding investigations, including the study of the laws of inheritance and hybrids, were continued with the same plants, and experiments with the radish were added. Results in connection with the study of the influence of chemical injections in producing mutations or variations in a pure line of wild silene were brought together for publication. The inheritance of certain characters was studied in a considerable number of plants, and a preliminary report on the results of some experiments is soon to appear. In variation studies special attention was given to the extent and use of bud variation, these investigations being conducted particularly with potatoes and oxeeye daisies. A study of the cumulative action of selection with pure lines of wheat and oats was continued in cooperation with this department. Work of similar nature was also done to some extent with cowpeas and garden beans.

A number of interesting facts was brought out by the various investigations on soils and soil fertility conducted with the Adams

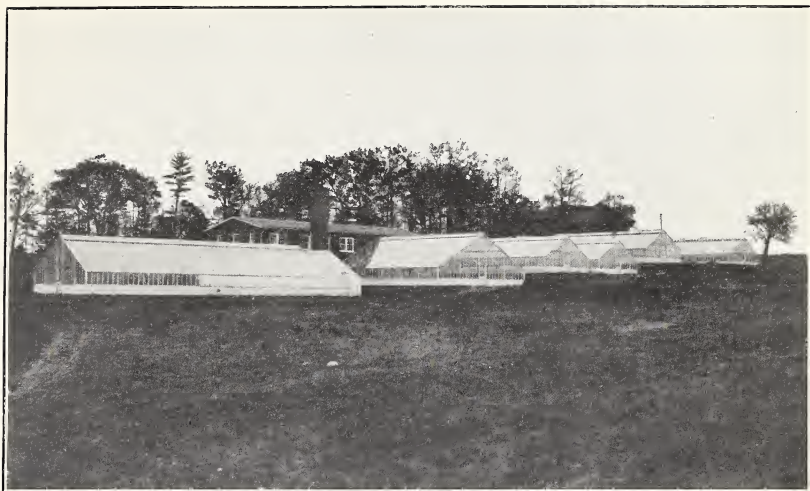


FIG. 1.—NEW GREENHOUSE LABORATORIES, NEW YORK CORNELL COLLEGE AND STATION.



FIG. 2.—NEW DAIRY BARNS, NEW YORK CORNELL COLLEGE AND STATION.

fund. The growth of a legume with a nonlegume gave the latter a greater protein content than when it was grown alone. The growth of alfalfa was found to increase the nitrifying power of the soil for at least certain periods in the growth of the crop. Both legumes and nonlegumes were shown to have a definite relation to the nitrate content of the soil on which they grow, the relation differing with different crops. The station advances the hypothesis that certain nonlegumes stimulate nitrification during their period of most active growth, and later have a depressing effect on the process of nitrate formation. The absorption of nitrate nitrogen by wheat plants grown in a rich soil was found not to be proportional to the growth of the plants, but to increase with a decrease in the soil moisture content and consequently with a decrease in the crop. This result is considered as a probable explanation of the high percentage of gluten in wheat grown in semiarid regions.

In studying the relation of lime to the growth of alfalfa, it was observed that the protein content of alfalfa grown on limed soil is markedly greater than when the plants are grown on soil in need of lime. In these experiments the difference amounted to 88 pounds of protein per ton of alfalfa hay. Investigations involving the application of fertilizers at different stages of growth of corn and oats have demonstrated that, under certain conditions and for certain crops, the application of fertilizers after the crops are growing effects a substantial economy.

The entomological work under the Adams Act was confined mainly to a study of the species of *Isosoma* on grasses and cereals. This work consisted of rearing the insects and studying the different species with reference to their taxonomy. The study of the life histories of the red bugs of the apple and of the plum leaf miner was begun as a new project.

The station also carried on numerous lines of work with Hatch and State funds. The timothy-breeding experiments under way for several years have resulted in a number of new forms which reproduce their characters true to type. The best of these were tested in the field and grown in isolated plats to secure pure seed for distribution. Corn-breeding experiments were carried on in four different sections of the State for the purpose of obtaining high-yielding and early-ripening strains of dent corn. The oat and wheat breeding experiments carried on in cooperation with this department for several years were continued.

The experimental soil work consisted of an examination of the chemical composition and of certain physical properties of the more important types of soil in the State, a comparison of the practice of fertilizing for hay crops with that of fertilizing for the grain crops in a rotation of timothy three years followed by corn and oats each

one year, and the study of the causes of the formation of soil granules and the conditions involved in these processes. A bulletin on the effect of fertilizers applied to timothy on the corn crop following it was published during the year.

The results of steam sterilization of soils showed that steaming at two atmospheres' pressure for two or four hours reduced the nitrates to nitrites and ammonia, and that the ammonia was mostly derived from organic nitrogen. Ammonification and nitrification were practically nonexistent during the three months following steaming.

The department of farm practice inaugurated a new series of experiments to test the relative efficiency of different ways of manuring land and different ways of plowing. The department of farm management and field crops studied pasture management and made comparative tests of races of flint and dent corn in different sections of the State. The results indicated that on hill lands flint varieties are superior to the dent varieties. The agricultural survey work conducted by this department has brought together information of fundamental nature bearing on questions of farm management.

The department of plant physiology conducted investigations on the action of nutrient solutions of different composition upon plant growth, the relation of plants to single nutrients or to preponderance of a particular nutrient, the antidotal effect or antagonistic action of different mineral constituents of the soil solution, nitrogen fixation by fungi, stimulation and toxicity, respiration and fermentation, and the physiological relations of bacteria.

The department of plant pathology continued its studies of the diseases of grapes, beans, ginseng, apples, nursery stock, and the like, including special tests of lime-sulphur as a fungicide. New lines of work on the following subjects were started and were conducted under industrial fellowships provided from private sources: The uses of sulphur and its compounds as fungicides; the heart rots of forest, shade, and fruit trees; the effect of cement dust on the setting of fruit, injury to foliage, etc.; the diseases and insect pests of fruit and fruit trees; and the diseases of potatoes. Plant lice were found to be the chief agents in spreading fire blight of pears, apples, quinces, etc. The destruction of all sources of infection by cleaning out all cankers and removing all diseased bark and disinfecting the cuts with a corrosive sublimate solution of 1:1,000 is recommended. A bulletin on peach-leaf curl advises early spraying with Bordeaux mixture or lime-sulphur solution before the buds are far advanced.

The department of horticulture was engaged in monographing the varieties of peonies, sweet peas, and gladioli, and published a bulletin on the classification of the peony. A special study of the specialized truck regions of the State was begun during the year.

The department of entomology conducted special studies of the snow-white linden-moth, the Mallophaga infesting domestic fowls, the cabbage aphis, and the larch case bearer, apple maggot, and other insects. Extensive experiments were also made on the treatment of onion thrips and the use of lime-sulphur washes for scale insects.

The work of the dairy department consisted of studies of moisture in butter, of the factors affecting the efficiency of cream separators, and of the factors affecting the accuracy of the Babcock test, and experiments in manufacturing Camembert cheese. Tests of 34 herds of cows were made and a bulletin giving the results of the second year's work is in course of preparation.

The experimental work of the department of animal husbandry had reference mainly to the relation of food standards to milk production. The results of experiments carried on indicate that mangels raised at a cost of \$4 per ton and judiciously used to replace one-half of the grain ordinarily fed are profitable for milk production. A comparison of different substitutes for skim milk in raising calves showed that skim milk was the best substitute for whole milk and also that good calves can be raised without skim milk or milk of any kind after the first 30 days. Dried skim-milk powder proved the best substitute for skim milk at an economical cost.

The department of poultry husbandry compared the results of free range versus bare yard and close confinement on laying and breeding stock and the accumulative effect of natural versus artificial incubation on the health and productivity of fowls, and studied the importance of constitutional vigor in selecting fowls, the relation of inheritance to the function of egg production, age as a factor in breeding, the feeding of color pigments in nutrition experiments, seven methods of feeding chickens to broiler age, and crossbreeding White Leghorns and Barred Rocks in comparison with pure breeds.

The department of agricultural chemistry made considerable progress in the study of the lime requirements of soils.

The extension work conducted by the college of agriculture included a large number of cooperative experiments with farmers on the use of fertilizers for certain crops, corn and potato selection tests, comparative cost of producing dry matter in root and silage crops, etc. One feature of the extension work is the agricultural survey, carried on by counties, and the soil survey of the State, conducted in cooperation with the Bureau of Soils of this department. The soil survey as at present organized is able to cover only about one county a year. Wherever experiments are conducted field meetings are arranged on the experimental plats for the purpose of field demonstrations. Several farm trains were run during the year. For the fiscal year 1910-11 the State appropriated \$12,000 for extension work, which is an increase of \$2,000 over the year before.

The publications received from the station during the year were as follows: Bulletins 268, The Substitution of Roots for Concentrated Foods in Rations for Milk Production; 269, Substitutes for Skim Milk in Raising Calves; 270, Fancy Cheeses for the Farm and Factory; 271, The Incomes of 178 New York Farmers; 272, Fire Blight of Pears, Apples, Quinces, etc.; 273, The Effect of Fertilizers Applied to Timothy on the Corn Crop Following It; 274, Building Poultry Houses; 275, Effect of Steam Sterilization on the Water Soluble Matter in Soils; and 276, Peach-leaf Curl.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$13,500
United States appropriation, Adams Act-----	11,700
Total -----	25,200

A report of the receipts and expenditures for the Federal funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The State appropriated \$200,000 for the maintenance of the college of agriculture for the fiscal year 1910-11, an increase of \$25,000 over the appropriation of the previous year. The station continues to increase and strengthen its work in a variety of lines important to the agriculture of the State. The policy pursued of differentiating college extension and experimentation work in the organization is giving good results and is working out to the satisfaction of all the departments concerned.

NORTH CAROLINA.

North Carolina Agricultural Experiment Station, *West Raleigh*.

Department of North Carolina College of Agriculture and Mechanic Arts.

C. B. WILLIAMS, M. S., *Director*.

A number of changes occurred in the staff of the North Carolina station during the year. J. Michels, dairy husbandman, who resigned to engage in commercial work, was succeeded by J. C. McNutt. J. D. Cecil was appointed animal pathologist of the station. Some changes also took place in the corps of assistants, but these did not take effect until after the close of the fiscal year. In accordance with a law passed in March, 1909, the printing of the station publications was done at the expense of the State. The improvements made during the year included the installation of a system of water works, the erection of a tool and implement shed, and the construction of a number of smaller buildings for different purposes.

The Adams-fund work in plant pathology included the investigation of a new apple disease caused by an undetermined fungus. The

study of lettuce diseases was continued and the results prepared for publication. A method of treatment based on the laboratory investigations was worked out. In connection with the studies in nitrification, samples of the different soil types existing in the State were secured and the nitrifying and ammonifying efficiency was determined. It appears from the data accumulated that the associative action of other bacteria with the nitrifying organisms is an important factor. The chemical work done on this project showed that the results obtained when working with soils are not the same as those secured with solutions. Work was also pursued in the improvement of methods for comparing the nitrifying efficiency of soils and making colorimetric and qualitative tests for nitrates.

The study of the relation of geology and chemistry of soils to fertility was continued actively, and the chemist, cooperating with the department of agronomy, analyzed about 200 samples of soil in connection with this work. Considerable work was also done on the investigation of the cause of the development of suckers on corn and its influence on the yield.

The horticulturist continued to study the cause of "double flower" and sterility in blackberries and dewberries. Results secured in studying the Muscadine grapes and published in Bulletin 209 of the station have brought out the fact that these grapes are generally self-sterile and that male vines must be planted in the vineyards to insure satisfactory fruiting. The study of the transmission of characters in hybrids of the *Rotundifolia* grapes was taken up in continuation of the work with this species.

In entomology, special attention was given to the investigation on the pickle worm and work was taken up on the life history of the corn billbug and allied species. The investigation on the toxicity of cottonseed meal, in which the chemist, animal husbandman, and veterinarian cooperated, was actively carried forward. Among other results secured, it was found that meal from certain kinds of sea-island cotton seed is as toxic as the meal from upland seed.

Numerous lines of station work, some of them having been taken up during the year, were supported by Hatch funds. The work in agronomy included variety, culture, and rotation tests with a number of cereal and forage crops, selective breeding experiments with cotton and wheat, a study of the dropping of squares of different varieties of cotton under different seasonal and soil conditions, and a comparison of various cover-crop combinations. Canada field peas and Burt oats, and hairy vetch and wheat gave excellent results as green forage crop combinations for hogs. It was also found that velvet beans mature in the Piedmont section of the State and that they produce a very satisfactory growth of vines. The results of fertilizer tests indicated that all fertilizer treatment hastened the maturity of cotton and corn on a poor type of Cecil sandy loam soil, and further,

that this type of soil is not in need of potash when growing cereals or cotton.

Feeding experiments with poultry showed the value of abundant range, the necessity of a sufficient amount of ash and protein in the ration, and the economy of feeding skim milk to laying hens during the summer.

The horticulturist found that the dropping of immature figs is due to the fact that many of the trees are seedlings of the Smyrna fig, which must be fertilized from other types in order to bring fruit to maturity.

Feeding experiments conducted by the department of animal husbandry showed that cottonseed meal when fed not to exceed 2 pounds per day per animal and when properly combined with other feeds can be used for feeding horses and mules, and that beef cattle can be fed quantities ranging from 6 to 7 pounds per day, on an average, and for a period of 100 to 120 days without injurious results. It was also demonstrated that corn silage and corn stover can be used as substitutes for cottonseed hulls. In pig-feeding experiments it was demonstrated by the use of digester tankage that feeds rich in ash and protein are necessary to develop bone and muscle in hogs.

The entomologist, among other lines of work, tested a proprietary preparation of sulphur and arsenate of lead as a spray against the plum curculio, and demonstrated the effectiveness of using a solution of 1 pound of arsenate of lead in 10 gallons of water in combating the elm-leaf beetle.

The work of the station in dairy husbandry consisted largely in feeding experiments with different rations, including a feeding test with calves, in which cottonseed meal was used with different amounts of bran and oats with silage and hay. Practical methods of manufacturing cottage and Neufchatel cheeses of uniform grade and quality and on a small scale were worked out.

The publications received from this station during the year were as follows: Bulletins 200, Feeding Fermented Cottonseed Meal to Hogs; 201, Scuppernong and other Muscadine Grapes—Origin and Importance; 202, Manufacture and Marketing of Cottage Cheese, Skim-milk Buttermilk, and Ice Cream; 203, Corn Weevils and other Grain Insects; 204, Some Factors Involved in Successful Corn Growing; and 205, Insect Enemies of Cantaloups, Cucumbers, and Related Plants.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation	1,400.00
Farm products	4,879.56
Total.....	34,279.56

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The work of the North Carolina station in general is proceeding regularly and in accordance with definite plans. Although conditions limit the range of the station work, increased interest in its operations is manifested throughout the State.

**Agricultural Experiment Station of the North Carolina State Department
of Agriculture, Raleigh.**

B. W. KILGORE, M. S., *Director.*

The principal lines of work followed at this station during the year included soil investigations to determine the fertilizer or plant food requirements of different crops on the different types of soil occurring in the State, and experiments with crops, including cotton, corn, and other cereals, peanuts, cowpeas, soy beans, and tobacco, to determine which of these are best adapted to the various soils and what methods of cultivation and general crop management are most efficient. The work was conducted on the five test farms or substations in Iredell, Buncombe, Edgecombe, Pender, and Transylvania Counties, representing different types of soil, and on a large number of similar areas or individual farms over the State where different kinds of soil are found to be typically developed. Analyses of the soils on which the work was done were made and some of the results of the work were published during the year.

Work was in progress on the testing of varieties of the leading crops for the different parts of the State, and the improvement of these varieties by breeding and selection was also given attention. Experiments with potatoes, cabbage, celery, and apples were carried on in the mountain section of the State, and with strawberries, lettuce, pecans, and peaches in the eastern or coastal plain section. Feeding experiments were made with beef cattle to determine the profitability of beef production when fed on the crops generally grown on the farms of the State.

A large amount of demonstration work in addition to the farmers' institute work and embracing spraying, pruning, and other orchard practices, selection of seed, methods of cultivation, fertilization, and other phases of production for different crops was conducted, and cooperative work with this department on the Scuppernong grape was carried on at the Pender test farm. Cooperative work with tobacco was also in progress.

The work of the station is supported from the finances of the State department of agriculture, which amounted to \$164,000 for this year

and of which from \$60,000 to \$80,000 was used in experimental work and for carrying the results to the farmers.

Bulletins presenting the results of the work of the station were issued during the fiscal year ended June 30, 1910, on the following subjects: Reports on Fertilizers and Fertilizer Inspection; Variety and Culture Tests with Wheat, Oats, and Rye; Pecans; Annual Report of Farmers' Institutes; Stock Feeds; Tenth Annual Report on Food Adulteration; Oil Bulletin; Variety and Distance Tests with Corn and Cotton; Fertilizer Analyses (2 bulletins); The Home Canning of Fruits and Vegetables; The Culture of the Cowpea; Some Common Birds on the Farm; Insect Enemies of Tobacco; Winter and Spring Work in Selecting Seed Corn; and July and August Work in Selecting Seed Corn.

NORTH DAKOTA.

North Dakota Agricultural Experiment Station, *Agricultural College.*

Department of North Dakota Agricultural College.

J. H. WORST, LL. D., *Director.*

The lines of investigation and the personnel of the North Dakota station remained practically without change during the year. Much of the work, however, was interrupted and hampered by the burning of the chemical laboratory December 24, 1909, which resulted in considerable loss of data and material collected for work as well as apparatus and equipment. The total loss was estimated at \$63,000, including \$35,000 worth of apparatus. To replace this laboratory a large and spacious fireproof building for the chemical department is under construction. The new veterinary building was completed, furnishing the veterinary department with an entirely new plant and equipment with exceptionally good arrangements. The building is constructed to form essentially three separate but connected structures, containing laboratories and classrooms in one part, a stable in another, and a dissecting room in a third section. An operating room and a killing room are also provided.

Progress was made in the Adams-fund investigations of the station, although the destruction of the chemical laboratory retarded some of the work. In the milling project studies were made of the milling and flour and bread producing quality of wheats grown on different soils, of different varieties of wheat, of frosted wheats, bin-burned wheats, and all wheats ripened in the stack as compared with shock-thrashed grain. Studies were also made of the content in the flour of gluten, ash, and organic phosphates in relation to the loaf volume. The acid phosphate content was found to vary considerably in wheats grown on different soils and in different seasons, and also

in different varieties. The legislature contributed \$3,000 for the laboratory work of this line of investigation.

In studying the nutrition of the wheat plant in its relation to soil conditions, special attention was given to humus, the development of efficient methods, the relation of conditions of soil to its formation and character, and the availability of the plant food in humus.

The swamp-fever investigation made good progress. It was found that cases in horses otherwise appearing to be entirely healthy may be infectious for a long time without showing clinical evidence except a periodical rise in temperature. The results have further shown that the disease is transmissible by subcutaneous and intravenous injection and the ingestion of blood coming from affected horses, and that the etiologic factor is an ultramicroscopic or filterable virus. The popular conception of swamp fever as being essentially an anemia was shown to be erroneous. No efficient therapeutic agent has thus far been found.

The work on disease-resistant flax now carried on in cooperation with farmers has shown that the varieties selected are not only strongly resistant to diseases but that they are also especially good yielders even upon new lands. The results of investigations on the relation of bacteria and fungi in soil to cropping methods are considered as showing that the early deterioration of the wheat crop on new lands is not necessarily due to the chemical depletion of the soil, but to the introduction of special parasitic fungi which bring about soil sickness in the same sense that flax soils become sick. Attention was also given to the methods of the distribution of these diseases and the means of their eradication or prevention. It is pointed out that some of these wheat diseases attacked quack grass, and that this seems to explain the strong influence that a quack-grass soil has in preventing the growth of wheat upon the same area. Observations on sterilized soil from the rotation plats showed that the bacteria content soon came back to the original but that the disease fungi returned less rapidly. Work was also taken up during the year on the changes taking place in flax during the process of ripening, and in connection with the retting of flax fiber and on the products of distillation from flax straw.

Under the Hatch Act the agriculturist gave considerable attention to plant breeding and seed distribution, dry-land cooperative trials, and animal husbandry work. The work in plant breeding was greatly enlarged, particularly in breeding corn, alfalfa, and winter grains. The yields of corn in ear-to-row tests ranged from 96 to 37.7 bushels per acre. Golden Dent No. 950 seed corn was widely distributed by various means, though largely through sales direct from the institution.

No. 316 blue-stem wheat was largely disseminated through the demonstration farms. This wheat is the result of 17 years' work, and is the first blue-stem seed distributed by the station. The yield in this very dry year was $27\frac{1}{2}$ bushels per acre on 5 acres, while the average wheat production for the entire State is estimated at only $5\frac{1}{2}$ bushels per acre. No. 959 winter rye proved hardy to a considerably greater degree than the common rye sown in the country, and also gave better yields. The cross of winter wheat and winter rye made by the station two years ago continued to prove fertile and vigorous, and to promise to be a good yielder. The improved seed grains are tested on the demonstration farms and the five substations located in 29 of the 48 counties of the State and are largely distributed from these points.

The studies of crop rotation, soil exhaustion, and fertility maintenance were extended and largely revised during the year. This work is planned to determine positively the requirements for the maintenance of the soil of the Red River Valley. The moisture studies were continued on the rotation plats and were extended to the demonstration farms and also carried out in the dry-land farming work at the five substations.

The work in animal husbandry included feeding experiments with hogs, in which different feeds were compared. (Pl. IV, fig. 2.) It was found that corn produced a much larger proportion of fat than barley and in consequence made a poorer grade of pork. It required 18 per cent more of barley than of corn to produce a given gain in weight. Another test showed that ground rejected wheat produced good gains when fed to swine with shorts. In comparison with corn it required 8.9 per cent more rejected wheat than corn to produce the same gains, but the quality of pork produced was better than that produced on corn. Observations were made on the cost of milk production with the various rotations available in the State. In breeding work with poultry the use of a good sire for three generations on mongrel stock brought the flock up to a high grade. A comparison of cold and warm housing and ventilation for chickens gave the best results from the cool housing. The fowls produced more eggs and showed greater vigor than where the temperature remained above freezing. The effect of exposing eggs to low temperature before incubation as affecting their fertility was studied, and it was found that eggs chilled up to three hours hatched well. The enforcement of the stallion inspection law is incumbent directly upon the head of the department of animal husbandry. An examination was made of 2,522 stallions, of which 2,346 were granted licenses.

The work of the horticulturist was seriously interfered with by the drought and the prevalence of grasshoppers. The year's work

with vegetables was almost a failure, but the results with reference to drought resistance of different forest trees was of interest. It appeared that the trees having a long taproot like the black walnut and those with a vigorous rooting habit like the willow were best able to withstand the dry weather. In diminishing order of drought resistance the species ranked as follows: Jack pine, bull pine, Russian wild olive, black walnut, white willow, green ash, white ash, hackberry, cottonwood, elm, box elder, soft maple, and white birch.

The veterinarian, in addition to his Adams-fund work, conducted the State Serum Institute and cooperated with the State Live Stock Sanitary Board.

The chemist conducted an inspection of paints, oils, and varnishes under a State law, and issued a bulletin on the composition of ready-mixed paints as secured in the market. A special donation of \$1,500 for tests of the serviceability of paints and oils and various mixtures was made by paint manufacturers. The chemical department also conducts inspections of foods and drugs, beverages, fertilizers, and feeding stuffs, and analyzes illuminating oils for the State oil inspection, special State appropriations being made for this service.

The botanist continued his observations on weed destruction by means of various spraying solutions. The State enacted a pure-seed law, and furnished funds for its execution and a well-equipped laboratory for seed investigation.

Cooperative work is carried on with this department in irrigation at the Williston substation, with reference to the amounts of water applied per acre, times of application, behavior of small grain, alfalfa, sugar beets, and market products under irrigation in that climate, and upon two of the types of soils which that farm represents. Dry land and irrigated farming on the same crop are here compared. During this dry season the yields without irrigation were only worth harvesting for forage. Other dry-land cooperative trials were conducted at Edgeley and at Langdon. The work on hardy alfalfa at the Dickinson substation was given considerable attention. It has been possible to make alfalfa survive under the severe winter conditions as well as under dry-land farming methods. Experiments on alfalfa were also in progress at the Williston, Langdon, and Edgeley substations. Work at the new substation at Hettinger was carried forward during the year, and this station is now ready to begin experimental work.

The average yields secured on the 24 demonstration farms during the adverse season of 1910 were much greater than the average yields for the entire State. The station also did work in connection with a breeding circuit in cooperation with the Bureau of Animal Industry and with college-extension and farmers' institute work.

The following publications have been received from this station during the year: Bulletins 84, Fattening Hogs; 85, Glanders; 86, Some Ready-mixed Paints; 87, Seed Disinfection and Crop Production—Methods and Types of Machinery Needed; Special Food Bulletins 11–23; and Paint Bulletins 1–3, Report on Service Condition of Paints.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation-----	16,281.45
Miscellaneous-----	5,468.31
Balance from previous year-----	11,286.10
Total-----	61,035.86

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The North Dakota station has in progress a large amount of valuable experimental work, but with the pressure for extension work of various kinds the experimental work is likely to suffer unless special provision is made for it. The demonstration work of the station is conducted on an extensive scale, and, together with the special training and institute work, a very marked influence on the agriculture of the State is being exerted.

OHIO.

Ohio Agricultural Experiment Station, Wooster.

C. E. THORNE, M. S. A., *Director*.

The last general assembly appropriated \$166,295 for the support of the station, including, among other items, the following amounts for the different station departments: Administration \$26,300, agronomy \$16,475, animal husbandry \$15,000, botany \$10,900, chemistry \$3,700, cooperative experiments \$20,470, dairy husbandry \$8,000, entomology \$5,000, forestry \$10,000, horticulture \$10,950, nutrition \$4,000, and soils \$10,500. In addition to the allotments for the different departments there was an appropriation of \$17,000 for the completion of the nutrition building, for which \$5,000 was allowed by the previous assembly, \$3,000 for an extension of the power house, and \$4,000 for the purchase of additional land. These appropriations provide for extension work along several lines, including the establishment of a new department, that of dairy husbandry.

An act was passed April 13, 1910, providing for the establishment of county experiment farms. This law is wholly optional in character, merely providing a way by which the counties may inaugurate

local demonstrations of the station results and by which local problems and conditions may be better studied by the station.

The Adams fund work was carried on along the original lines and no new projects were taken up. The results secured in the study of certain projects were published during the year in bulletin form. The project on the increase and fixation of desirable properties in plants included work with 130 strains of alfalfa propagated from seed from as many different plants, 245 strains of red clover, 100 strains of corn, 569 strains of oats, 125 strains of soy beans, and 1,560 strains of wheat. Pedigreed strains of corn have been developed which are thus far yielding 5 to 14 bushels per acre more than the original varieties; pedigreed strains of oats and wheat are yielding 3 to 6 bushels more than the original stock; and soy beans $2\frac{1}{2}$ to 6 bushels more. In the work with corn it was found that seed ears of less than normal length tend to reduce the yield, and that the continuous use of ears having 1 to $1\frac{1}{2}$ inches of bare cob at the tip decreases the yield of shelled corn per acre. The use of merely crease-dented ears appears somewhat superior in yield to very rough-dented ears, and the weight of ear, other conditions being equal, is apparently a partial guide in the selection of productive seed. The cylindrical shape of the ear proved less important than the other characters mentioned.

The project of the rôle of lime and phosphorus in the maintenance of soil fertility is carried on by the director in cooperation with the departments of chemistry and agronomy. In connection with the rotation plats a very large number of analyses of the crops grown were made and from the results thus far obtained with wheat there appeared to be a direct relation between the composition of the wheat and the treatment of the soil. This work is bringing out the differences in composition between soils of the limestone and sandstone areas of the State, and appears to point out that the lack or abundance of phosphorus in the soil influences the composition of the crops produced.

The work on the rôles of phosphorus and other mineral elements in animal nutrition has thus far been confined to phosphorus compounds, including the value of the various compounds in foods, the separation of the various groups of phosphorus compounds in food-stuffs, and the effects of conditions of growth on the mineral nutrients in blue grass. In Bulletin 207 of the station it is shown that the specific or characteristic effects of foods are influenced in important ways by the ratio of the inorganic acids to the inorganic bases which they contain. In Bulletin 213, published jointly with the Missouri Experiment Station, a comparison of balanced rations shows that the muscular growth produced was generally in accord with the content of the foods in organic phosphorus compounds.

Bulletin 215, also published during the year, describes new and improved methods for distinguishing between organic phosphorus, which contributes to the growth of all the tissues of the body, and inorganic phosphorus, which contributes only to the growth of the bones. The results of these studies showed that glycerophosphates are more useful than the other organic and inorganic compounds found in foods, and it is pointed out that as the content of farm foods of phosphorus in this condition is very small, it may be a profitable practice under certain conditions to add glycerophosphates to the food much as we use common salt.

Each department of the station had in progress a large number of investigations supported by Hatch and other funds. The botanist studied a bacterial disease of raspberries and blackberries, a disease of peaches, *Fusarium* diseases of potatoes, a *Fusarium* wilt of cabbage, and also gave considerable attention to diseases of the cereals. Spraying experiments were conducted to test various fungicides in comparison with lime sulphur. The bacterial blight of oats is reported upon in Bulletin 210 of the station. The study of diseases of forest and shade trees was taken up in cooperation with the Forestry Department. About 425 samples of seeds were tested during the year for purity, and germination tests were made of about 200 samples. Weed-spraying experiments were carried on, and salt solutions, 3 pounds to 1 gallon of water, were found effective for destroying poison ivy, horsenettle, elder, etc., while iron sulphate proved excellent for destroying the oxeye daisy. The plant-breeding work of the department consists mainly of hybridizing wheat, oats, and tobacco. Several hybrids of wheat and oats were tested at the station and on the outlying farms. Several hundred tobacco hybrids were under test at Germantown, and this part of the work is carried on to some extent in cooperation with the Bureau of Plant Industry.

In entomology studies were made of the wheat jointworm, bark beetles, webworms, white grubs, insects affecting stored grain, etc., and spraying experiments were made for the control of apple pests. Most of the spraying work is conducted cooperatively, and it is planned to continue this plan for five or six years before making definite recommendations. The work of the department of agronomy consisted of testing old and new varieties, methods, rates and times of seeding, and the improvement of varieties by selection and breeding of alfalfa, clover, corn, cowpeas, special forage crops, meadow grasses, oats, soy beans, and wheat. Some 25 different sources of alfalfa seed were studied, together with 35 varieties of corn, 25 of which are pedigreed strains developed by the station, 4 varieties of field peas, 10 species of grasses, 60 varieties of oats, and 51 of soy beans, 34 of which are superior pure-line selections.

Milling and baking tests of the station's different varieties and selections of wheat were taken up, and interesting variations have already been brought out by the results of this work. A study of two systems of farming, one with and the other without live stock was inaugurated, and the effect of deep and shallow plowing and subsoiling was studied at the station and at the various State test farms. This department also carried on a large amount of cooperative work with each of the important crops in several counties of the State.

In animal husbandry, feeding and breeding experiments were in progress with horses, cattle, sheep, and hogs. The sheep work was largely conducted in the southeastern portion of the State and included comprehensive studies on wool production, lamb feeding, etc. The studies in wool production are prosecuted from the standpoints of both the wool producer and the textile worker. The study of various proportions of grain and roughage in the ration for beef production and in the use of various kinds of roughage for mutton production was taken up.

Experiments in pasture improvement were undertaken at the station and at the Southeastern Test Farm, where work with poultry was also begun on a limited scale. In the hog-feeding experiments, the influence of individual animals, dry-lot feeding, different rations, corn with and without supplements, such as soy beans, rape, grass, etc., were studied. The work of this department will hereafter include the production of meat and wool and the feeding of horses, while the new department of dairy husbandry will take over the management of the dairy cattle.

The horticultural department made observations on self-fertility of fruits, the value of smudges for frost protection, the use of fertilizers for grapes, and on mulching with apples. In the work of establishing a system of orcharding for the hilly regions of the southern part of the State, it was found that the so-called sod-mulched trees were of decidedly better growth than those grown on soil without the mulch or where the land was cultivated. The mulch plats contained more nitrates and more moisture than the other plats. Irrigation and cultivation experiments with strawberries and tomatoes were begun in the open and the improved work with tomatoes, lettuce, cucumbers, and other vegetables showed good results. This department with the department of entomology worked in cooperation with orchardists in various sections of the State, with the result that the possibility of bringing back many abandoned orchards into very profitable production has been convincingly demonstrated.

The forestry work of the station is now practically a separate department. Its work consists very largely of experiments in mixed plantings of coniferous and deciduous trees, observations on rate of

growth, cooperative planting in the State, and nursery work. At Wooster, the nursery of this department contains about 225,000 seedling trees, including 10,000 ornamental trees to be tested under various conditions in different parts of the State. Work was carried on in the reconstruction of three native wood lots at the station farm, and several wood lots are also being reafforested at the Southeastern test farm. From the nature of the work, the greater part of the operations of this department are carried on away from the station. Its cooperative work consists of work with farmers and with State and municipal institutions. Out of 208 farmers applying for help in forestry work, 73 applied for aid in managing wood lots, being double the number for the previous year. Forestry work on the cooperative plan was conducted at seven State and municipal institutions and at one private institution.

The cooperative work of the station was quite extensive and was in charge of the cooperation department, which is well supported by State funds. This work consisted very largely of studies of methods in farm management, and four assistants were appointed and assigned to different parts of the State for the purpose of overseeing definite problems. These assistants visit their respective regions and supervise the experimental work. Cooperative field experiments were conducted with corn, alfalfa, grasses, soy beans, potatoes, and other crops, and a few fertilizer experiments were started. The State has made provision for putting a third station exhibit on the road during the fair season, and the State railroad commission has arranged with the railroads for a uniform rating for the shipment of these exhibits to the various county fairs applying for them.

In the farm-management work about 80 dairymen and 100 poultrymen cooperated with the station, and on a small number of farms all the enterprises entering into their operation were studied in cooperation with this department. In addition to this work, statistics of crop production were collected and arrangements were made with the Bureau of the Census for a tabulation by townships of Ohio's corn crop, in order to compare these data with the statistics collected annually by the township assessors.

The following publications were received from this station during the year: Bulletins 203, *Studies in Diseases of Cereals and Grasses*; 204, *Forest Conditions in Ohio*; 205, *Twenty-eighth Annual Report, 1909*; 206, *The Maintenance of Fertility: Field Experiments with Fertilizers and Manures on Tobacco, Corn, Wheat, and Clover in the Miami Valley*; 207, *The Balance Between Inorganic Acids and Bases in Animal Nutrition*; 208, *Protection of Fruit Trees from Rodents*; 209, *Rations for Fattening Swine*; 210, *The Blade Blight of Oats—A Bacterial Disease*; 211, *Third Annual Report on Forest Conditions in Ohio*; 212, *Corn Judging: Studies of Prominent Ear*

Characters in Their Relation to Yield; 213, Specific Effects of Rations on the Development of Swine; Circulars 96, Essentials of Successful Field Experimentation; 97, The Work of the Department of Cooperative Experiments; 99, Cooperative Dairy Work; and 100, The Centers of Agricultural Production in Ohio.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	13, 000. 00
State appropriation	166, 295. 00
Farm products	14, 775. 62
Miscellaneous	3, 183. 63
Balance from previous year.....	93, 327. 35
Total.....	305, 581. 60

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The general condition of the Ohio station is very satisfactory and the State funds for maintenance are increasing. Much of its new equipment, both present and prospective, is for the betterment of its organization and for the increase of its influence throughout the State.

OKLAHOMA.

Oklahoma Agricultural Experiment Station, *Stillwater*.

Department of Oklahoma Agricultural and Mechanical College.

J. A. WILSON, B. Agr., *Director*.

The year at the Oklahoma station was marked by a number of changes in personnel and a general reorganization of the station staff. Administrative difficulties culminated in the spring in Director J. A. Craig's retirement. In consequence of this L. A. Moorhouse, agronomist, W. L. Burlison, assistant agronomist, W. O. Morris, horticulturist and botanist, W. R. Wright, assistant bacteriologist, and several members of the clerical force resigned. The station was thus deprived of a majority of its leading workers and placed under the necessity of recruiting and reorganizing its force from the director down. Time was required for this; the conditions were not such as to readily attract qualified men to the vacancies, and some of the positions were filled by men with little experience in advanced lines of work, so that the work of the station was placed in temporary uncertainty.

Such a recurrence of unsettled conditions as the Oklahoma station has been peculiarly subject to interferes with the continuity and efficiency of its investigations in a degree which the governing boards seem not to appreciate. Three of the leaders and originators of its

Adams-fund projects were lost to the station before their investigations were brought to any conclusion. Their records remain; but as far as the important qualities which the individual contributes to an investigation a new beginning is necessary. Time will be required to fully overcome the results of these changes and to restore confidence in this station as a place where conditions conducive to effective experiment and investigation may be found.

After the close of the year James A. Wilson, formerly superintendent of one of the district agricultural schools of the State, was appointed director; N. O. Booth, horticulturist and botanist; and A. H. Wright, assistant agronomist and temporarily in charge of that department.

The construction of the sheep barn begun last year was completed (Pl. VI, fig. 2), and a greenhouse, to be used by the station for work in horticulture, was built during the year. Improvements were also made in the department of chemistry.

The station receives no direct appropriation from the State, but by law is placed in charge of certain lines of work from which it derives some revenue from the dairy commission, the nursery inspection, and the pure-feed and fertilizer funds.

Progress was made in the Adams-fund work of the station during the year. For the purpose of studying the fruit buds, apple trees 12 to 14 years old were selected and placed under observation, and some preliminary studies were made in the laboratory. Considerable work on the factors affecting the setting of fruit on the tomato was carried on in the greenhouse. The effects of planting in dry versus moist earth and of the age and moist condition of pollen were also studied.

The veterinarian, in connection with the project on artificial impregnation, studied the vitality of the sperm cell under normal and abnormal conditions. In the cottonseed-meal work it was found that in the animal fed on this substance the effect on breeding had been marked. The study of drought resistance in corn and breeding of resistant strains was continued. Mammoth White, derived from Boone County White, a large plant and good yielder, but not very drought resistant, was crossed with Squaw, an early variety. The studies at the station and in the field include observations on the plants in general and their leaf structure, root development, size of ear and cob, the conditions of the soil, the best time to apply pollen, etc. It has been found that it requires two or three years to fix the cross.

The work in the sheep-breeding project, carried on with Dorsets, Shropshires, and Merino sheep, was confined the past year largely to raising pure-bred lambs and securing wool samples for study. Progress was also made in the investigation of a fungus disease of



FIG. 1.—NEW DAIRY BARN AT THE OKLAHOMA STATION.



FIG. 2.—NEW SHEEP BARN AT THE OKLAHOMA STATION.

San José scale, and the facts gathered from field experiments seem to indicate that this disease will be a valuable factor in the control of the insect.

The various lines of work undertaken by the station with the Hatch fund were continued during the year. The department of agronomy harvested the eighteenth crop in the experiment with winter wheat grown continuously with and without manure. The records for the past 11 years show an average yield of 14 bushels per acre without manure and of 24 bushels with manure. Corn, cotton, and Kafir corn have been grown in the same way for 8 years. Rotation experiments covering 3, 5, and 6 year periods were continued, and a fertility test with alfalfa, using lime, nitrogen, phosphoric acid, and potash in different amounts, was carried on. Variety tests were made with wheat, cotton, oats, corn, Kafir corn, and other crops of importance to the region. Breeding experiments were conducted with corn, cotton, Kafir corn, etc. Individual plants of cotton were ginned for the purpose of making fiber tests. Experiments were also conducted on methods of cultivation and depth of plowing for corn. The selection of Bermuda grass was continued in a grass garden maintained for the purpose.

The department of chemistry made analyses of alfalfa plants in connection with fertility tests and studied the inorganic constituents of the grain, stalks, root, and whole plant in connection with the corn and sorghum projects under the Adams fund. Digestion experiments were conducted with sheep fed on prairie grass, Bermuda grass, and alfalfa.

Considerable work was done by the department of entomology on spraying to control the melon aphid. Studies were also made on the garden webworm, the locust borer, the twig girdler, and on parasites of the green bug. In connection with this work practical methods have been suggested for controlling the plum aphid, the twig girdler, and the melon aphid.

The planting experiments in forestry were continued by the departments of horticulture and botany. A bulletin reporting the results of this work points out the possibilities of tree planting when the proper methods are employed. Variety tests of orchard and small fruits were made on a small scale, together with tests of varieties and methods of cultivation of tomatoes.

The veterinary department made a somewhat extensive bacteriological study of flavor of milk and cream with special reference to the grading of these products. Work was also begun on the production and distribution of serum for hog cholera. The station makes a charge of 1 cent per cubic centimeter for serum. The distribution of blackleg vaccine was continued with other than the Federal funds.

The animal husbandman conducted experiments with hogs in which half and full rations of corn were fed in the house in connection with

pasturage. This work, now carried on in the new hog house, includes the study of various combinations of alfalfa meal, alfalfa hay, and tankage added to corn. Green alfalfa and corn in varying rations was compared with green rape in similar combinations of corn.

The work in dairy husbandry consisted of a study of the production of dairy cows under present dairy conditions in Oklahoma and the testing and calibrating of glassware used by commercial dairies and factories of dairy products.

Cooperative work is carried on with the farmers of the State in the control of the chinch bug and San José scale by means of infection. Cooperative work with the district agricultural schools at Warner, Tishomingo, Broken Arrow, Lawton, and Helena includes variety tests and a study of plant-food requirements. In cooperation with this department the station is studying the effect of different climatic conditions upon the composition of red Kafir corn, black Kafir corn, and milo maize upon the diseases attacking the sorghum plant and upon the permanency of the beardless characteristic in breeding barley. The station officers performed some extension work in connection with farmers' institutes, meetings of agricultural and live-stock organizations, and agricultural demonstration trains.

The following publications were received from this station during the year: Bulletins 84, Variety Test of Peaches; 85, Bermuda Grass; 86, Tree Culture; 87, Corn Culture; 88, The Southern Plum Aphid; and the Annual Report for 1909. The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
Miscellaneous.....	3,991.22
Total.....	31,991.22

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

It is hoped that more stable conditions may prevail at this station and that under the new organization the various lines of work having an important bearing on the agriculture of the State will be followed as originally outlined.

OREGON.

Oregon Experiment Station, *Corvallis*.

Department of Oregon State Agricultural College.

JAMES WITHYCOMBE, M. Agr., *Director*.

The staff of the Oregon station remained practically the same as the year before, but since the close of the fiscal year the following changes have taken place: E. F. Pernot, bacteriologist, who resigned to enter commercial work, was succeeded by E. G. Peterson; F. L.

Griffin was appointed research assistant in plant pathology; and H. F. Wilson and V. I. Safro research assistants in entomology; R. W. Rees succeeded C. C. Vincent as research assistant in horticulture, and C. C. Lamb was placed in charge of the station poultry plant. H. J. Umberger was appointed superintendent of the dry-farm substation at Moro.

The State, which has thus far given no direct assistance to the station, appropriates \$7,500 annually for the maintenance of the Eastern Oregon Experiment Station at Union, \$3,000 annually, in cooperation with this department, for the substation at Hermiston. and \$2,500 annually, also in cooperation with this department, for the maintenance of the dry-farm station at Moro. During the year the main part of the agricultural building was completed, at a cost of \$55,000. The agronomy wing of this structure was completed some time ago, at a cost of about \$35,000, and it is contemplated to construct the horticultural wing during the coming year in order to complete the building as originally planned.

Progress was made on the different Adams-fund projects upon which the station is at work. The project on the pollination of the apple was continued and the work extended to cover both the apple and the pear. In studying the affinities existing between varieties, it was found that the pollen of particular varieties used on the pistils of certain other sorts has an immediate detrimental effect on the fruit, size being the character first affected. Tests were also made of the sterility of varieties and of reciprocal crosses. Laboratory studies were made on the development of the fruit bud, together with observations on the blossom, the female element, the embryo, the effect of pollen on tissues immediately surrounding the seeds, the fruit and its development, the vascular system of the fruit, etc.

In the study of gummosis in the cherry, work was continued on the isolation and verification of the organism causing the disease, and apparently good progress in this direction was achieved. Observations on the susceptibility of varieties, the effect of stock, and other factors were also made and methods of control were tested. The life-history studies of the fungus causing apple-tree anthracnose were continued and it is believed that in another season's work the project may be brought to a close.

Work on the irrigation project in the Rogue River Valley, which is conducted on four different soil types and under other varying conditions, made satisfactory progress. Investigations were conducted on the downward course of the water used in irrigating orchards, and on the influence of different amounts of water applied with different frequency on the temperature of the soil and the general condition of the tree, including vigor, disease resistance, bud and wood growth, fruit production and quality, cell structure of leaf, fruit and wood, and other factors of a like nature.

The study of lime-sulphur, its use and effect, was carried on in co-operation with the chemist. A chemical study of the substance was made and the results published in the Journal of Industrial and Engineering Chemistry for June, 1910. Among other results, the influence of hot weather on the injurious effect of the spray was shown. In connection with the work on soil leaching, the effects of various fertilizers were studied. It was found that the soils under investigation were more largely affected by gypsum than by lime, and that the effect consisted of the release of potash. Absorption tests and studies of the waters of the principal rivers of the State were carried on in the laboratory.

Studies on the drying of hops showed that drying at low temperatures is necessary to insure high quality. Good results were secured by drying at 120° F. Investigations bearing on the time of picking and on the translocation of constituents in the plant were also in progress. Chemical studies of the different parts of the hop plant were made with a view to determining its plant-food requirements. The resin content of the choice Oregon hop was found to be equal to that of the continental hop of Europe. Methods for determining resins in commercial samples were perfected and a basis for grading samples was thus obtained.

In the project on incubation, studies were made on carbon dioxide in incubators and under the hen, and attention was also given in connection with this project to a study of the cause of mortality of incubator chicks and its prevention.

In addition to the Adams-fund projects, a number of other subjects supported by the Hatch fund received attention. In cooperation with the chemist, the horticulturist studied the effect of irrigation under a variety of conditions on the composition of the apple. The horticulturist further tested cover crops and their influence in orchards, and worked with varieties of vegetables, small fruits, and orchard fruits. Orchard-culture experiments were carried on, and among the different cover crops tested *Vicia sativa* or *V. villosa*, with either winter oats or rye, proved most successful in western Oregon, while *V. villosa* proved to be the only leguminous crop suitable to withstand the winters at the eastern Oregon station and in the Grand Ronde Valley. Some horticultural work was also done at Union and Umatilla under State appropriations.

The chemist pursued work on spraying materials, including arsenicals and their injury. It was found that calcium arsenate can be substituted for lead arsenate with generally good results. Peppermint was grown on beaver-dam soils to test its oil-yielding capacity under the particular conditions. The chemist also had charge of the fertilizer-control work.

The department of agronomy made soil-moisture determinations in connection with irrigation work; conducted experiments to determine

the effect of manure, inoculation, and different forms and amounts of lime on alfalfa; tested varieties of wheat, barley, field peas, and corn; and pursued breeding work with kale and kohlrabi.

The animal husbandman conducted a series of feeding experiments with pigs; the entomologist gave attention to work on the brown aphid; and the dairyman followed some work along practical lines.

The station did considerable cooperative work among the farmers and dairymen of the State in the introduction of cereals and forage plants. Grain was supplied to farmers in new agricultural sections, and selected seed of kale was distributed largely among dairymen. Cooperative work in orchard management was followed for the purpose of demonstrating methods of culture and testing varieties adapted to the foothill regions of the western part of the State.

The publications received from this station during the year were as follows: Bulletins 103, An Investigation of the Mortality of Incubator Chicks; 104, Pollination of the Apple; 105, Culture of Small Fruits; 106, Spraying for Peach Fruit Spot; 107, Commercial Fertilizers and Insecticides; 108, Insecticides and Fungicides; Circulars 5, Thousand-headed Kale; 6, Alfalfa in Western Oregon; and 8, Pamphlet for Distribution on the Farming Demonstration Train.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation -----	16,100.00
Farm products-----	3,246.47
Miscellaneous-----	3,508.08
Total-----	50,854.55

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Oregon station has great opportunities, and the interest in its activities is keen. With its work further systematized and differentiated from the instruction and extension work, both as to funds and working force, the position of the station would be materially strengthened. State appropriation is greatly needed to enable it to meet the present requirements of agriculture in the State.

PENNSYLVANIA.

The Pennsylvania State College Agricultural Experiment Station, *State College.*

T. F. HUNT, D. Agr., D. Sc., *Director.*

During the year T. I. Mairs, head of the department of animal husbandry, was placed in charge of the department of agricultural education in the college and W. A. Cochel was appointed to succeed

him. A few other changes in the minor positions on the station staff also occurred during the year. Since the close of the fiscal year T. F. Hunt, the director, has begun a vacation of nine months abroad and Alva Agee has served as acting director during his absence. The revenues of the station were practically as outlined in last year's report.

The Adams-fund work, as in the previous year, was confined to three different projects. The horticultural study of the causes influencing the yield and quality of apples was continued in 12 orchards, containing 91 acres and located in different parts of the State, and in the new orchard of 29 acres on one of the college farms. The different factors studied in this work included soil, location, tillage, mulching, fertilizers, cover crops, and others which may control and limit quantity and quality. The results thus far secured indicate, among other things, that in the use of fertilizers nitrogen is usually the limiting factor. The fertilizers used have not shown any consistent ability to improve color or size of fruit.

In agronomy, work on the long-time fertilizer and rotation experiment and on the chemical, physical, and biological variations in the soil as brought about by this treatment was continued. The crop raised was the twenty-ninth grown on the plats, and striking differences were apparent. A study of the different forms of lime indicated that finely pulverized limestone is as prompt and effective as caustic lime in correcting soil acidity and promoting the growth of clover. This investigation was extended to permanent pasture. Taking advantage of these long-time fertilizer plats, this department is cooperating with the station in studying the soil solution, the changes in the form and amount of nitrogen, and the relation of the fertilizer used to the soil and the composition of the crop.

The other line of investigation under this fund is conducted by the Institute of Animal Nutrition (described on p. 228).

Considerable work, supported by Hatch and other funds, was also in progress. Experiments were conducted relative to soil treatment as affecting the success of alfalfa, corn, wheat, oats, barley, and clover and timothy. This work includes tests of deep and shallow plowing, time of plowing, use of lime and fertilizers, methods of cultivation, and variety tests of oats, potatoes, wheat and corn, corn and timothy, breeding, seed testing, and other lines of similar activities.

The experiments on tobacco, as previously, were carried on in co-operation with this department in Lancaster County under a State appropriation of \$2,500.

The animal husbandry department continued the feeding experiment in which bulky and concentrated rations were compared and found that under Pennsylvania conditions the bulky ration was the more profitable. A continuation of shelter experiments showed that

steers fed in an open shed on succulent rations, including silage, made more rapid and cheaper gains and attained a higher finish than similar cattle fed in the same way in the basement of a barn. These results confirm the experiments made by Armsby, which indicated that a warm temperature is not necessary for fattening animals. Poultry-feeding experiments were conducted in which rations containing various amounts of crude fiber, ranging from 2 to 8 per cent, were fed to laying hens. The results indicated that an excessive amount of crude fiber reduced the egg yield and injuriously affected the health of fowls.

The dairyman continued feeding tests based on results of respiration calorimeter experiments with roughage and concentrates to determine the relative economy of the bulky and the concentrated rations. Observations were also begun to learn the relative sources and degrees of contamination of market milk from the time it is drawn from the cow until it is delivered to the consumer. The test of the milking machine was continued, this being the third year of the work.

The botanist made further progress in the study of clover diseases, giving special attention to anthracnose and to the nature of apple canker, which appears to be caused by a fungus associated with the oviposition of the snowy tree cricket. A form of root gall of the apple, possibly of fungus or bacterial origin, was also studied. Preliminary work was done to determine the possible cause and control of winter blight of greenhouse tomatoes.

The attention of the horticultural department during the year was largely confined to cabbage, tomatoes, and asparagus. Marked variation was found to exist in the same varieties of cabbage and tomatoes from different sources of seed, and special irregularity was noted in some of the most important varieties. The results indicated the need of improved methods of seed production. With asparagus, rust resistance received much attention through selection and breeding. Work with strawberries was carried on to study the adaptability of varieties to limestone soils and to test methods of culture with and without irrigation. The experiments with the vegetable crops included various cultural and fertilizer tests.

The forestry work consisted of experiments in timber preservation, tree planting, methods of collecting and handling forest-tree seeds, growth measurements, pure and mixed planting, nursery handling, etc. The forest nurseries now contain over 2,500 tree seedlings. Many acre plats were planted to determine their suitability for growing seedlings of the different species in that region. Cooperation was carried on with the Forest Service in two of its projects, and the department also worked with private owners in the State in making forest plantations and in the management of forest areas.

The chemist collected data on the limestone soils of the State; on hair, hoof, and leather refuse as sources of nitrogen in mixed fertilizers; and on other problems of a similar nature.

Members of the station staff gave lectures in connection with six special trains sent out by two of the leading railways of the State. They also attended various agricultural meetings at the college and elsewhere.

The publications received from this station during the year were as follows: Bulletins 92, Concentrated Lime-sulphur: Its Properties, Preparation, and Use; 93, A Study of Pennsylvania Butter; 94, Variety Tests of Wheat; 95, Pig Feeding Experiments; 96, Cabbage Strain Test; 97, Milling and Baking Test; 98, Potato Variety Test; 99, Lime-sulphur Solution; and 100, Orchard Fertilization.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation -----	5,000.00
Fees -----	12,616.00
Farm products -----	13,288.05
Balance from previous year-----	4,871.68
Total-----	63,775.73

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Pennsylvania station has secured the hearty sympathy of the progressive men of the State, and the result is increased State appropriations coupled with an increased demand for service.

The Pennsylvania State College Institute of Animal Nutrition, State College.

H. P. ARMSBY, Ph. D., LL. D., *Director*.

The investigations of the institute were conducted in cooperation with the Bureau of Animal Industry of this department, and also with the Pennsylvania Experiment Station, a portion of the Adams fund being assigned to this work. There was no material increase in buildings or equipment, and the staff remained the same in number as during the previous year. F. W. Christensen returned to duty from a year's leave of absence, taking the place of R. A. Lichtenhaeler, and J. W. Calvin was succeeded by H. Cloukey, and R. C. Jones by H. A. Dodge. Since the close of the fiscal year F. W. Christensen has taken up work in animal nutrition at the New Mexico station.

The principal investigations of the institute during the year consisted of a comparison of the energy value of corn meal with that of hominy feed manufactured from the same lot of corn. Inci-

dentially also determinations of the energy values of the mixed hay used as the basis of the rations were made. Two animals were used for the investigation, which included 5 periods of 3 weeks each for each animal, or 10 in all, during each of which the metabolism of the animals was investigated by means of the respiration calorimeter, the methods of experimentation being substantially the same as in previously published work with a few minor changes.

During the year Bulletin 128 of the Bureau of Animal Industry, giving a full discussion of the experiments on the influence of type and age on the utilization of energy by cattle, outlined in last year's report, was completed and the results of investigations by J. A. Fries upon the methods of bomb calorimetry were published as Bulletin 124 of the same bureau.

PORTO RICO.

Porto Rico Agricultural Experiment Station, *Mayaguez*.

Under the supervision of A. C. TRUE, Director, Office of Experiment Stations,
United States Department of Agriculture.

D. W. MAY, M. Agr., *Special Agent in Charge*.

The new office and laboratory building, which was begun in 1909, was completed and the equipment installed during the past year. This building has proved well adapted to the comfort and convenience of the staff.

The work of the station has been along the same lines as previously reported. In the chemical department a considerable amount of analytical work has been carried on, and in addition investigations have been made on soils and plant nutrition. One of the problems taken up was the formation of calcareous hardpan, which was found to be present in a number of localities, causing considerable loss in connection with various plantings. A large amount of work has been carried out on the causes and means for correction of chlorosis of pineapples in certain districts of the island. This trouble seems to be connected with the lime content of the soil, and in connection with this investigation a study has been begun on the lime requirements of various plants. The work on the sick soils due to the superabundance of bacteria has been continued, and field experiments on disinfection are in progress.

The entomologist has continued his studies on insect pests of citrus trees, and prepared a bulletin describing the principal insects and suggesting means for their control. An investigation has been begun on the insects attacking coffee, particular attention being paid to the injury caused by ants. Through the station considerable interest has been aroused in beekeeping, and a large number of broods have been disposed of to go to coffee plantations.

The plant pathologist is studying the diseases of a number of economic plants, among them coffee, cacao, pineapples, citrus fruits, and bananas. Experiments on soil disinfection for the prevention of the *Fusarium* disease on pineapples were so successful that treatment on a field scale was made during the past year. Spraying experiments with Bordeaux mixture for the control of citrus scab in Porto Rico have been carried on, but the results indicate that under present conditions the disease can not be controlled in this manner. A study was begun on the fungi causing root injuries to sugar cane, and a number of species have been identified.

The work with coffee has been continued and extended, experiments being made on the renovation of old plantations and the establishment of new ones. A number of foreign coffees have been introduced and some of them are now of a bearing age. In addition to the introduction of new varieties, methods of transplanting, fertilization, and cultivation are being considered.

Plantings have been made of a large number of tropical economic plants, including vanilla, rubber-yielding plants, cacao, etc., and some investigations looking to the reforestation of portions of the island have been begun. The horticulturist is carrying on a special study on the reasons for the rapid deterioration of vegetables when grown from northern seed, a large number of varieties being experimented with.

The work in improving the live stock of the island is progressing favorably, and the station has introduced six more horses during the year. The woolless sheep introduced from Barbados have proved well adapted to their surroundings, but there is need of some improvement in their meat-yielding qualities. The experiments with pigs and poultry have been quite successful and the surplus is in great demand by planters and breeders.

The publications of the station for 1910 consisted of the Annual Report; Bulletin 9, Sugar Cane in Porto Rico; Circulars 11, Soil Disinfection in Agriculture; and 12, On the "Sick" Soils of Porto Rico.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$28, 000. 00
Sales and other funds.....	5, 814. 93
Total	33, 814. 93

The relation of the station and its work to the people of Porto Rico is growing closer with each succeeding year. This is evidenced by the increasing number of visitors seeking information, the growth of the correspondence, and the numerous requests for assistance that involve a personal visit of some member of the station staff.

RHODE ISLAND.

Rhode Island Agricultural Experiment Station, Kingston.

Department of Rhode Island College of Agricultural and Mechanic Arts.

H. J. WHEELER, Ph. D., *Director.*

At the Rhode Island station the changes on the staff during the year were limited to the appointment of an assistant each in the departments of agronomy and biology. The station equipment was improved by the construction of a cool cellar for the storage of vegetables, and of a hospital building for use in the investigation of poultry diseases. The State made no appropriation for the station.

Satisfactory progress was made in the different Adams-fund projects. In conducting the work on the causes of losses of broiler chicks it was found that much of the ill effect of feeding cottonseed meal can be overcome by feeding with it generous amounts of bone ash and of calcium carbonate. Experiments designed to show the reason for this fact and for the differences in the efficiency of certain other high protein foods were continued.

In the study of the influence of previous crops on the growth of subsequent plants, the effect of 16 different crops on the growth of onions was observed, with a view to finding an explanation for the behavior in each case. Attempts were made to check the plat work with pot cultures in which the various fertilizer constituents were changed. Continued investigations on the blackhead disease of turkeys still further confirmed the view that it is caused by a coccidium rather than by an amœba, as previously supposed. It was found that many different kinds of wild and domestic birds are apparently subject to an attack of the same or a very similar organism.

The results of determining phosphorus deficiency of soils by analyzing the turnips grown upon them seem to show that the percentage of phosphorus in the dry matter is a fair indication of the amount of phosphorus in the soil. In studying the influence of sodium salts on the more important organic constituents of plants it was observed that where sodium salts were substituted for potassium salts potatoes gave greater yields the following year than those grown with an abundance of potassium available to the plants. The effect of potassium on the translocation and deposition of starch was also studied in connection with this project.

Research into the laws governing the breeding of pigeons was continued cooperatively with L. J. Cole, of Yale University. Results secured on the inheritance of color, color patterns, feathering and webbing of feet, and of other characters were arranged for publication. Under this project studies were begun on the inheritance of

egg production, and observations were continued on the pheasant and bantam hybrid produced in connection with this work. A new project in the form of studies of the lime and magnesia requirements of plants was begun during the year, the work the past season including experiments with lime, limestone, magnesian lime, and other calcium and magnesium compounds.

A large amount of experimental work, especially with field crops, was conducted by the station with the Hatch fund. This work included rotation experiments, liming soils, and observations on the residual effect, and tests with corn, cover crops, alfalfa, clover, and grasses. The station's practice of liming for clover and of fertilizing grass land has been quite generally adopted throughout the State. The station results with alfalfa have encouraged a number of farmers in the State to take up the growing of this crop. In addition to culture tests, studies were made on the adaptability of different strains of alfalfa to local conditions and their resistance to disease.

Further results in the rotation studies with rye, clover, and potatoes with the use of commercial fertilizers, including lime, indicate that for the improvement of neglected soil, as well as for general soil management, this method may be followed with success. The general improvement of the soil was found to have far less beneficial effect upon the rye crop than upon potatoes and clover. Results of experiments in weed destruction showed that iron sulphate may be used to control the daisy in hay fields, mustard in cereal fields, and dandelions on lawns, but that charlock is not readily controlled by the use of this substance. The most satisfactory results were obtained from the use of a 20 per cent solution, applying about 100 to 150 pounds of iron sulphate per acre, and by spraying only on bright days, when the prospects for continued pleasant weather were good.

The chemical department of the station studied the gain and loss of nitrogen in soils due to the growth of legumes, some of the less available sources of nitrogen in fertilizers, the effect of floats used in connection with stable manure, and the wet method of making available the nitrogen in leather, wool waste, and similar substances.

Studies were made of ropy milk or cream and its causes, and in laboratory experiments carried on in this connection it was found possible to produce ropiness in good milk or cream at will by inoculating the same with small amounts of pure cultures of a micro-organism regarded as probably closely related to *Bacillus lactis viscosus* of Adametz. This organism was also isolated in pure culture from the white specks in butter made from the ropy cream.

The number of farmers of the State cooperating with the station has been increased to nearly 150, being an increase of 50 during the year. Other cooperative work in addition to the pigeon-breeding experiments consisted of testing in the field newly propagated swamp

blueberry plants, and testing the method of hill spacing as compared with the usual method of planting corn. Both lines of work were conducted in conjunction with the Bureau of Plant Industry of this department. The station does practically no extension work, which is in the hands of the college.

The following publications were received from this station during the year: Bulletins 133, Weeds—Their Eradication and Control; 134, Abstracts of Feeding Experiments—Analyses of Commercial Feeding Stuffs; 135, Further Results in a Rotation of Potatoes, Rye, and Clover; 136, Ropy Milk in Rhode Island; 137, Analyses of Commercial Fertilizers; 138, Analyses of Commercial Fertilizers; 139, Studies of the Needs of Rhode Island Soils; and the Annual Report for 1909.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
Individuals.....	2.00
Miscellaneous.....	1,782.94
Balance from previous year.....	5,883.82
Total.....	35,668.76

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Rhode Island station, although in need of funds, continued to develop its work during the year and to secure results of great value to the State and far beyond its borders.

SOUTH CAROLINA.

South Carolina Agricultural Experiment Station, *Clemson College*.

Department of Clemson Agricultural College.

J. N. HARPER, B. S., M. Agr., *Director*.

The South Carolina station pursued its work actively during the year and made progress in various lines of study. The college and the station were conducted under an arrangement entered into about a year ago which places the control of the college very fully in the hands of the president and the station and substation in charge of the director. The personnel of the station remained practically as it was the year before.

The Adams-fund work of the station was pursued with encouraging success. In the investigation of the strongyloid parasites, the entomologist, in cooperation with the veterinarian, secured material for study from herds of cattle and sheep in different parts of the State, and the work done was with reference to the time of infesta-

tion, the feasibility of vaccination, and the manner in which the parasites find their way into the animal. As in the previous year, attention was mainly given to the hookworm and stomach-worm disease in calves and lambs. It was found that upland and lowland show a great difference in the prevalence of these parasites, and that calves pastured on upland may be kept free from the disease. During the last two years calves kept on a clean upland pasture remained in good health. Sheep kept for 12 months on a pasture that was heavily infested two years before developed no symptoms of the disease. The entomologist also continued the study of the temperature relations of insects, giving special consideration to the factors affecting hibernation, in order to determine whether parasites may be artificially hibernated on injurious insects. Studies of the squash bug showed that temperature did not affect hibernation, but in case of another species the opposite was found true. The various species studied were found to be differently affected by temperature conditions.

The cottonseed-meal project was continued, feeding cows relatively large quantities of the meal for a long period. Some individuals were very much more quickly affected and succumbed more rapidly than others. Feeding from 6 to 8 pounds of the meal daily to dairy cattle for an extended period resulted in lessened production, udder troubles, and abortion, and in some cases in unthrifty condition. Progress was also made in the study of the poisonous effect of cottonseed meal on hogs, which was carried on cooperatively by the veterinarian and the chemist. Apparatus was devised for conveniently securing large quantities of chemical extracts of cottonseed meal, and these were fed to hogs in relatively large amounts. Attention was specially given to different forms of phosphoric acid, and apparently the effects varied with the different forms of the acid used.

A large amount of hand pollination was performed in studying the effect of pollen on barren stalks of corn, and the investigation of the relation between soil and the quality of the cotton staple was carried on in cooperation with cotton growers and expert graders of lint. Although the prevalence of anthracnose interfered with the work the past season, the data collected indicate that the soil had an influence on the length of fiber and that the rainfall also was an important factor. A preliminary report on the cotton-anthrachnose project was made last year, and the work was continued actively by the plant pathologist. Inoculations were made on 30 varieties which proved susceptible, and the question of how the disease finds its way into the boll was studied. The work with *Rotundifolia* grapes involved a large amount of hand pollination, considerable data were collected, and, incidental with the work, some study was made on methods and time of pruning.

Work under the Hatch fund was pursued during the year by the different departments of the station. The entomological department carried on field work on the cotton rootworm in the western part of the State and on a new wireworm in the southern part, where the soil especially needs humus to prevent the injury. Experiments were made with rye, grown as a trap crop, to keep the insect from attacking the rice fields. The plum curculio was also studied, and during the winter experiments and observations were made in the greenhouse. The experimental field work previously carried on under the State inspection and quarantine appropriations was placed in charge of an assistant field entomologist, a position created for the purpose and supported with State funds. Cooperative work on the root louse and wireworm affecting corn and cotton is in progress with this department.

In plant pathology the causes of sweet-potato rots were investigated, and six different fungi not thriving at ordinary room temperatures were isolated. In a storehouse under temperature control the ordinary fungi could be kept out when the temperature ranged from 50 to 60° F., but a special fungus then appeared. The need of shifting the location of storage pits from time to time was demonstrated. Slips from diseased potatoes were planted for the purpose of studying black rot. Work on a plant-disease survey in the State was carried on in cooperation with this department.

In horticulture the effect of frost on peaches grown in different elevations and exposures was studied, varieties of apples, Japanese persimmons, pears, grapes, and bush fruits were tested, and breeding work with different fruits was followed. Work was also pursued to develop a variety of asparagus immune to rust, and attention was given to fall and winter vegetables with reference to dates of planting and their resistance to low temperatures.

The chemist conducted pot experiments with oats to determine the availability of different forms of nitrogen used as fertilizer. Soil analyses were made in connection with experiments with cover crops on different types of soil in cooperation with this department. An experiment was also in progress to determine the cause of failure to grow cowpeas in a certain locality. Studies were made of basic slag with reference to availability of phosphoric acid, and a number of insecticides were studied analytically.

In agronomy, fertilizer, rotation, and breeding experiments with cotton were continued, and observations were made to determine the relative value of nitrate of soda, sulphate of ammonia, and cottonseed meal as sources of nitrogen for cotton, corn, oats, and wheat. Various forage crops and cereals were tested, and a study was made of the best plants for winter cover crops in a rotation of corn and

cotton. Different grasses were compared as to their value for terraces, with the result that Texas blue grass proved most satisfactory. In cooperation with this department, varieties of soy beans were tested, and bur clover, crimson clover, and alfalfa were grown. The experiments with alfalfa show that northern seed is best, that much lime is needed, and that inoculation does not seem to have very much effect. Inoculation also had little effect with cowpeas, but its influence was quite marked with soy beans and crimson clover.

The animal husbandman and veterinarian tested home-grown crops with a view to reducing the cost of carbohydrates for dairy herds. Horse-breeding experiments were continued, this study being mainly one of cross-breeding, using the German coach and standard-bred horses as types. In cooperation with this department, work was done with hog-cholera serum to determine how long its potency is retained, the quantities to be used at different ages, and the effect of different preservatives on the substance.

At the coast substation, experiments were made with apples, pears, peaches, plums, grapes, blackberries, asparagus, onions, cabbages, and other vegetable crops, and special attention was given to figs. Eight acres were devoted to fertilizer experiments and 1 acre to testing grasses and forage crops. Rotation experiments with sweet potatoes as the main crop in the rotation were also in progress. The drainage system put in on the station grounds about a year ago is working satisfactorily.

The following publications of the station were received during the year: Bulletins 147, Analyses of Commercial Fertilizers; 148, Experiments with Hybrid Cottons; 149, Fall and Winter Cabbages; 150, Farm Management for Controlling Field Crop Insects; and the Annual Reports for 1907, 1908, and 1909.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
Farm products, including balance from previous year..	8,609.53
Total.....	36,609.53

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

In general, the work of the South Carolina station was actively prosecuted, and much interest was manifested in its operations.

SOUTH DAKOTA.

South Dakota Agricultural Experiment Station, *Brookings*.

South Dakota State College of Agriculture and Mechanic Arts.

J. W. WILSON, M. S. A., *Director*.

Satisfactory progress was made by the South Dakota station during the year. The changes in the station staff were confined to resignations and appointments of assistants. The new dairy barn for which the State appropriated \$10,000 was completed, and the new plant-breeding house was occupied by the horticultural department.

Work on the different Adams-fund projects was continued, and along certain lines considerable progress was made. The work on improving hardy wild fruits by breeding was carried forward on the basis that to secure hardiness it is necessary to have at least one of the parents hardy, and that a hardy fruit can not be developed by selection from tender varieties. The sand cherry was found to mate well with native and Japanese plums, and varieties combining the vigor and quality of the Japanese plum with the earliness and hardiness of the sand cherry have been secured. The two most promising new varieties were named Opata and Sapa.

The union of the native plum and the Chinese apricot has also given good results, and the three best varieties promising as profitable market fruits were named Hanska, Inkpa, and Kaga. Two new hybrids, Sansota and Cheresota, of which the sand cherry is the female parent and the De Sota plum the male parent, were sent out in the spring of 1910. The fruits of these sorts approximate the De Sota in flavor and size and the sand cherry in color. The hybrids of the purple-leaved plum of Persia with the sand cherry have turned out to be valuable ornamentals, following the sand cherry in stature of plant and glossiness of leaf and the Persian sire in the rich purple-red color of foliage. An extensive field experiment with apple-graft hybrids promises good results. The hybrids are made by taking two buds, halving each, and grafting them into a stock. Where only one grows a combination of the characters of the two seems to take place. During the winter and spring hybridizing work with raspberries from many parts of the world was continued on an extensive scale, and much seed for planting the next season was secured. The hybrid variety Sunbeam, previously reported as sent out from the station, is winning much favor over a wide area of the Northwest and is the hardiest raspberry so far produced.

Rotation and fertilizer trials were continued in the study of soil fertility. The series of rotations contain each a leguminous crop,

such as red clover, sweet clover, or peas, and in some tests the crop is plowed under while in others it is removed. The soils of the various plats were sampled and analyzed. Work on the histological and bacterial features of lumpy jaw was continued with improvements in the technique. Culture characters of the pus were studied and a record of cases was kept. The study on the digestion coefficient of South Dakota grain and forage plants, including brome grass hay, alfalfa hay, corn stover, lowland and upland prairie hay, bran, and Sixty-day and Swedish Select oats, when fed to horses, was practically completed during the year. Some preliminary work was done on the effect of alkali waters in dairying.

With Hatch funds the chemist continued his work on the breeding of sugar beets in cooperation with this department. This work has so far resulted in more than 40 different strains of selected beets, as many more cross-bred varieties, and a number of single individuals selected on account of unusual excellence. The aim of this line of investigation is to establish purely American types of sugar beets adapted in every way to the climatic conditions prevailing in the sugar-beet zone, and to overcome the necessity of using imported sugar-beet seed, much of which now results in beets varying widely in sugar content within the same strain or variety.

The botanist worked on the sexual stages of rusts, especially the *acidium* cup forms. Of the many species studied, so far only three have proved favorable for the study of the sexual fusions. Fungus diseases of the potato were also given attention, and spraying experiments in this connection were carried on in cooperation with the State entomologist. Observations were also made on fungi-attacking insects, especially the house fly. The distribution of noxious weeds, in particular the Canada thistle and quack grass, was studied together with methods for their eradication. In cooperation with the veterinarian, the botanist took up an investigation of an animal disease thought to be due possibly to ergot.

The new alfalfas brought over by the horticulturist from Siberia and other Asiatic countries were propagated in a limited way, and a small surplus was raised of seven very hardy varieties and sent out to station specialists and to other parties. The alfalfa work within the State, including the alfalfa trials in progress at the substation, was turned over to the agronomist.

The dairy department studied the acidity of creamery butter in its relation to quality, and found little or no uniform relation existing between the quality and the acidity of fresh butter. An acid test was found to be a valuable criterion in determining the extent and rapidity of deterioration in butter. A demonstration of cheap methods of keeping ice on the farm for use in creamery and dairy

work was made. Different methods of storage were tried and the percentage of ice lost was determined.

The agronomist continued the work in breeding corn for high protein and high fat content, comparing the profitableness of producing corn, oats, and clover with and without live stock on the farm, and testing durum wheats, scab-resistant potatoes, and over 6,000 alfalfa plants. Selections of clovers and alfalfa plants were made on the basis of foliage and seed production. Progress reports on the work with corn and barley were made in bulletin form during the year. The substations are operated under the department of agronomy of the station.

The department of animal husbandry made a further study of feeding lambs on different grain rations while on rape pasture, breeding western-bred ewes to pure-bred rams, and feeding steers of different ages on the same kind of grain ration to determine the relation of age to gain. The experiment in lamb feeding was closed out during the year and the results reported. Ten lambs receiving alfalfa hay gained 79 pounds more in 44 days than the same number of lambs receiving upland prairie hay, when each lot consumed the same quantity of grain. The results with 369 lambs showed that alfalfa hay with a grain mixture and a little linseed meal was markedly superior to any other grain or forage ration. Lambs fed a grain ration of South Dakota oats while on rape pasture made a larger gain than lambs fed a grain ration of corn or of barley while on the same kind of pasture. At this station loss attending the feeding of lambs on rape has not been greater than it has under ordinary feeding operations.

No other cooperative work than that already mentioned was done by the station, and a very limited amount of extension work is performed by the members of the station staff.

The publications received from this station during the year were as follows: Bulletins 113, Progress in Variety Tests of Barley; 114, Digestion Coefficients of Grains and Fodders for South Dakota—Experiments with Sheep; 115, Report of Work for 1907 and 1908 at Highmore Substation; 116, Acidity of Creamery Butter and its Relation to Quality; 117, Sugar Beets in South Dakota; 118, Corn; 119, Fattening Lambs; and the Annual Report for 1909.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15, 000. 00
United States appropriation, Adams Act-----	13, 000. 00
State appropriation-----	10, 000. 00
Land endowment-----	1, 898. 74
Farm products-----	3, 015. 35
Balance from previous year-----	1, 551. 21
Total-----	44, 465. 30

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The South Dakota station and its work are, in general, in good condition, and creditable progress was made in its important lines of investigation, although the funds at the disposal of the institution are limited and the demands upon the station are increasing.

TENNESSEE.

Tennessee Agricultural Experiment Station, *Knoxville*.

Department of the University of Tennessee.

H. A. MORGAN, B. S. A., *Director*.

A feature of the year's work at the Tennessee station was the progress made in organizing and developing the work of the two substations maintained by State appropriations, the progress made at the West Tennessee substation at Jackson being especially noteworthy. (Pl. VII.) At the central station there was little change during the year in organization or lines of work.

Progress was made in the work on several Adams-fund projects, particularly those relating to disease-resistant clover and alfalfa and to humus formation. The valuable resistant strains of clover and alfalfa, originated at the station, were tested in different parts of the State. Of disease-resistant clover, 38 acres were grown with a view to seed production as well as to testing its value. It is proposed to extend these investigations to a thorough study of the physiology of resistance, not only in the case of clover and alfalfa, but also with apple and pear blight and so-called tomato wilt. Studies on the life history of the fungus causing the anthracnose of clover were continued. The studies on humus formation were continued with four typical soils, and observations were made in this connection on the drainage water collected under several different conditions of depth of soil and manurial treatment. Pot experiments were also included, and the whole was supplemented by chemical investigations in the laboratory. In connection with this work, methods of determining humus were worked out and reported upon.¹

In the project on soil biology, soy beans were grown and bacteriological decomposition in humus in soils under controlled bacteriological conditions was studied. Investigations of the conditions affecting the life history of the cattle tick were continued. The study of the effect of temperature conditions upon the cattle tick was greatly aided by the use of a special refrigerating plant built for this and similar purposes. The investigations on the peach-tree borer

¹ Jour. Indus. and Engin. Chem., 2 (1910), No. 6, p. 269.



FIG. 1.—ADMINISTRATION BUILDING OF THE WEST TENNESSEE SUBSTATION AT JACKSON.
SEED HOUSE IN THE DISTANCE.



FIG. 2.—BARNS AND SILOS OF THE WEST TENNESSEE SUBSTATION AT JACKSON.

were carried forward in the field, and tests of several remedial measures were made in the young experimental orchard of the station.

Among the work done with Hatch and other funds, especial prominence was given to studies of the maximum capacity of soils and crops to produce feed. Breeding experiments were conducted with the common cereal crops for the purpose of increasing production, hardiness, and earliness. Similar work was also pursued with tall oat grass and soy beans. The cotton-breeding experiments in cooperation with this department have been carried on at the West Tennessee substation at Jackson since the spring of 1909. Some of the selections made in connection with these experiments were cultivated on the station farm, and considerable seed of the Trice variety was produced for distribution among growers. The opportunities offered at the West Tennessee substation for field experiments are considered superior to those under the control of the station elsewhere in the State. The soils are typical of the region and are practically unmodified by previous manuring, and lie well for experimental purposes. Variety trials of various farm crops as well as fertilizer and liming experiments were made. A series of crop rotations was begun and rates, dates, and methods of seeding for several crops were tested.

The meteorologist made a study of the relation of climate to crops, especially the relation between rainfall and corn production. The data collected and the observations made having reference to frost, the growing season, the mean annual rainfall and its monthly distribution, and similar factors, were published in bulletin form during the year.

The horticulturist conducted some experiments in orchard pruning and spraying, giving special attention to the peach crop. The results of some of this work showed that Bordeaux mixture is of no value as a remedy for peach scab, and is less valuable than self-boiled lime-sulphur as a remedy for peach rot. Arsenate of lead added to the earlier applications of either Bordeaux mixture or self-boiled lime-sulphur reduced the amount of wormy fruit. In an orchard heating test it was found that fires raised the temperature from 4° to 6° and saved the crop.

The veterinarian demonstrated the efficiency of hog-cholera serum in several herds.

The station cooperated with the State department of agriculture in seed testing, for the purpose of excluding serious weeds from certain cultivated crops in Tennessee under a recently enacted seed law. Spraying demonstrations were given in orchards in various parts of the State during the year, and farmers' institutes were attended by members of the station staff. Assistance was also given by the station staff at short courses in agriculture conducted by the State

department of agriculture, and at a 10-day course held by the university at the West Tennessee substation.

The publications of the station received during the year were as follows: Bulletins 87, The Relation of the Weather Service to the Farmers of Tennessee; and 88, Insuring the Peach Crop.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000. 00
United States appropriation, Adams Act-----	13,000. 00
Farm products-----	8,101. 81
Total -----	36,101. 81

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The distinctive element of progress by this station during the year was the extension of its work to different sections of the State. It is doing substantial work for the agriculture of the State, which is meeting with wide appreciation.

TEXAS.

Texas Agricultural Experiment Station, College Station.

Department of the State Agricultural and Mechanical College of Texas.

H. H. HARRINGTON, LL. D., *Director.*

Among the changes occurring at the Texas station during the year were the transfer of the station headquarters to the newly completed station administration building, the resignation of W. C. Welborn as vice director and agriculturist, and the promotion of H. L. McKnight from assistant agriculturist to agriculturist of the station. E. J. Kyle, O. M. Ball, and E. Schoel were relieved of station work. The new station building is practically fireproof and affords greatly improved offices and laboratory room. A State appropriation of \$1,000 annually for the current biennium became available for tobacco investigations in cooperation with this department at its tobacco station at Nacogdoches. The allotment for station printing in the budget was \$2,000.

The location of seven new substations authorized by the last legislature was decided upon by the locating board, consisting of the governor, lieutenant governor, and State commissioner of agriculture, as follows: At Pecos in Reeves County, at Lubbock in Lubbock County, at Spur in Dickens County, at Denton in Denton County, at Temple in Bell County, at Beaumont in Jefferson County, and at Angleton in Brazoria County. Of these the two last named are to give special attention to rice problems. The localities at which the several sta-

tions are to be situated have contributed liberally for their establishment, in some instances donating the land and erecting the necessary buildings and improvements.

Under the Adams fund the horticulturist continued the plant-breeding work on the blackberry and dewberry. A large lot of seedlings, including about 100 hybrids, have about reached bearing age and large numbers of other seedlings and hybrids are ready to be transplanted to the open ground.

Work on the soil project was actively pursued, special attention being given to the three essential plant-food elements and to humus and soil acidity, and part of the results were published. In Bulletin 125, a preliminary report on this work, the chemical composition of certain types of soil occurring in a number of the counties of the State is recorded. Results presented in Bulletin 126 of the station, as determined in about 200 pot experiments, indicate, among other things, a close relation between the yields of corn, and the quantity of phosphoric acid in the soil, and also show that the phosphoric acid removed by the crop in percentages of the active phosphoric acid decreases with the quantity of active phosphoric acid in the soil. In connection with this project, pot experiments were carried on in which the amounts of water percolating through different types of soil and the losses of plant food and fertilizers as shown by the drainage water were determined.

As a result of changes in the department of entomology, the project on the control of plum curculio on peach trees was discontinued and the work on the southern grain louse was completed for publication. A study of the physiological effect of powdered lead arsenate on beetles of the order Rhyncophora and with special reference to the cottonboll weevil was begun. The veterinarian continued investigations of swamp fever, giving special attention to methods of infection and means of control. Attempts were made to cause the disease by transmission of blood, urine, and bowel contents. The plant pathologist started on a line of work in the laboratory and in the field to determine whether inoculation with pure cultures of *Pseudomonas radiculicola* increases the number of nodules on the roots when grown in four distinct soil types occurring in large areas in the State, and whether the effect of inoculation varies according to these soil types and to what it may be due.

In addition to the Adams-fund investigations, the following important lines of work were carried on with the Hatch fund. The department of agronomy laid out in plats a 52-acre field and conducted experiments including tests of 30 varieties of cotton and 19 varieties of corn, fertilizer experiments with cotton and corn, ear-to-row breeding experiments with corn in which prize ears were compared with ordinary corn from the same counties, experiments with

regard to the width of rows and depths of plowing for cotton, studies of alfalfa to overcome difficulties in starting the crop in that region, rotation experiments in which corn, cotton, cowpeas, peanuts, oats, and soy beans are used in different combinations, methods of treating cotton seed for weevil control under the direction of the entomologist, a comparison of drilling and broadcasting cowpeas and sorghum, and fertilizer tests with leguminous crops.

The entomologist carried on field experiments on the control of the cotton-boll weevil, giving special attention to the use of arsenical poisons. The chemist prepared for publication the results of work on irrigation water, alkali soils, and the use of cottonseed meal as a human food. He also made studies of pecan oil and of wax. More than 600 samples of fertilizers and 1,000 samples of feed were examined in the chemical laboratories during the year.

In animal husbandry, feeding experiments were made with grade Shropshire lambs and yearlings, in which cottonseed meal and hulls, molasses, corn, and Kafir corn were compared. A ration of molasses, cottonseed meal, and hulls gave the best results with the lowest cost, while corn or Kafir corn with cottonseed meal and hulls was the most expensive. Feeding experiments were also carried on with hogs. In these experiments a pound of cottonseed meal per pig per day was fed for 60 days without injury to any of the animals.

The veterinarian made studies of remedies for Texas fever, and continued the hog-cholera serum work with funds from the State.

Cooperative fertilizer experiments were carried on with farmers of the State. Station officers were not engaged in extension work of any kind.

The following publications were received from this station during the year: Bulletins 109, Alfalfa; 121, Report of Progress at the Troupe Substation, Smith County, Tex.; 122, The Effect of Salt Water on Rice; 123, Commercial Fertilizers and Poisonous Insecticides in 1908-9; 124, The Pecan Case Bearer; 125, The Chemical Composition of Some Texas Soils; and 128, Cottonseed Meal as Human Food.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch act.....	\$15,000.00
United States appropriation, Adams act.....	13,000.00
Miscellaneous	818.90
Balance from previous year.....	956.82
Total.....	29,775.72

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Texas station, as a result of better equipment and improved organization, has been enabled to place its work on a more active and

systematic basis. The establishment of substations throughout the State will make added demands on the college station for thorough-going work and for experts of experience in all departments of the station.

UTAH.

Agricultural Experiment Station, Logan.

Department of the Agricultural College of Utah.

E. D. BALL, Ph. D., *Director*.

The Utah station carried on its work during the year practically without interruption by changes on the station staff. Some rearrangement was made in the personnel in order to facilitate meeting existing demands. The position of horticulturist remained vacant during the year, and experimental work in this branch was largely in abeyance. Since the close of the year, however, L. D. Batchelor has been appointed station horticulturist, and the horticultural work will again be taken up during the coming year. The work during 1909-10, in so far as State aid is concerned, was carried on under the biennial appropriation noted in the report of last year.

Work on the Adams-fund projects was actively pursued as a rule, and general progress was made. The entomological department gave special attention to the study of the life history and distribution of the alfalfa-leaf weevil and to methods for its control. Experiments demonstrated that its injury may largely be prevented by different cultural methods, the use of live stock in pasturing off the fields at certain seasons, and by certain mechanical contrivances for capturing the insects. A report upon the work up to the end of this fiscal year was prepared.

The investigation of the effect of arsenical sprays upon the life of fruit trees was continued in the laboratory and in the field. The results so far secured show that the corroding of the crowns of apple trees so commonly encountered is not due to the effect of arsenicals, as the ordinary spraying compounds in concentrated strengths have produced no injurious effect upon the bark of healthy trees. Even though in contact for the entire growing season, trees on which 160 times the ordinary amount of spraying compounds was placed did not show any injury at the end of the second year. The investigations on sugar-beet pests were with special reference to the cause of leaf curl.

The chemical department continued the study of the formation and movement of nitrates in irrigated soils, the agronomist cooperating in the growing of crops in connection with this project. A bulletin on this work was published during the year. The project was somewhat increased in scope by the addition of a series of

rotations and the cooperation of a bacteriologist detailed from the Bureau of Plant Industry. In the experiment so far carried on it was found that the nitric nitrogen tends to accumulate in the lower foot sections during winter and spring. On alfalfa land the concentration was found to be low, and cultivation seemed to increase the amount of nitric nitrogen, but this effect did not seem permanent.

The requirements of nitric nitrogen in the soil differed greatly with different plants. There was a steady decrease in the concentration of the nitric nitrogen content of potato and corn land from period to period, while that on alfalfa and fallow land remained nearly constant. On oat land the nitric nitrogen disappeared rapidly during the last few weeks of plant growth. On the gliadin project a study of methods was made, and milling and baking experiments were conducted with other funds.

The poultry department conducted the incubation and poultry-breeding work as outlined. Special stress was laid on the incubation project. A large incubator with several tiers of egg cases was constructed and fitted up with electric devices, thermometers, etc., for measuring carbon dioxid, moisture, and temperature. With this new incubator it is hoped to overcome most of the difficulties experienced in the operation of the ordinary machines. Experiments have indicated the machine to be superior for experimental work to anything yet tested. In the pedigree breeding work the number of hens increased and the work was extended to the third year of the chicken's life. Careful records were kept of every factor entering into egg production and the vitality of stock. Results have shown the value of selection in developing a laying strain of fowls, a marked correlation having been found in every case between high-laying mothers and their progeny. No special features were brought out in the study of the cause of the extensive losses of chicks during the first few weeks after hatching.

In addition to the Adams-fund work, a number of lines of investigation were carried on with Hatch and State funds. The department of chemistry studied the effect of dry farming on nitrogen formation in soils, and prepared the results for publication. In connection with irrigation investigations on peaches, the dry matter and relative proportions of flesh, skin, and stone were determined, and special work was done on milling and baking tests and on soil nitrate problems. The chemist also cooperated with the department of agronomy in studying the effect of formalin on the vitality of seed grain.

In the department of agronomy experiments were conducted for the improvement of alfalfa hay by making selections with reference to hay qualities from seven strains obtained from this department and by crossing and growing individual plants. Studies were also

made of the seed qualities of different strains of alfalfa on an acre at Benson, where conditions for seed growing are favorable. Experiments with potatoes related to size of tuber for planting, deep versus shallow culture, furrowing and flat culture, water requirements, number of applications in irrigation, shallow irrigation, and breeding by selection. With beans variety, culture, and irrigation experiments were carried on. An exchange of potatoes for seed was made between irrigated and dry farms in cooperation with the Bureau of Plant Industry. In the sugar-beet breeding work strict methods of pedigree breeding were employed and the total hereditary power of each original mother ascertained. The seed produced last year showed a gain of over $1\frac{1}{2}$ per cent in the sugar content as compared with the imported seed of the same original strain. This work has been in progress for eight years and was originally conducted in cooperation with the Bureau of Plant Industry. In connection with sugar-beet work the amounts of water and times and methods of irrigation were also studied.

From the work on formalin in its relation to the vitality of seed grain, it was found that the treatment was effective in preventing the loose and covered smut of oats, the covered smut of barley, and the bunt of wheat. A solution as dilute as 1 pound of formalin to 60 gallons of water reduced to some extent the vitality of the seeds of wheat, oats, and barley. Oats proved more resistant to the influence than wheat and barley. It was concluded that the seed may safely be treated for 1 hour in a solution of 1 pound to 50 gallons of water.

The work in animal husbandry was limited largely to a feeding test with 225 lambs, which were fed different amounts of different grains in connection with alfalfa hay from December 8 to February 19. It was found that one-half the ordinary grain ration with alfalfa gave good and economical results. The station has four Percheron mares which are used in field work. The cost of their keeping and of their work was recorded.

Irrigation work was pursued with State funds in cooperation with this office, and especial attention was given to the water requirements of peaches and apples. Some work along this line was also done with sugar beets and potatoes. The results of the first two years' experiments with peaches have shown conclusively that the character and amount of fruit produced can be very materially modified by the time of application of a given amount of water. It was further demonstrated that an excessive amount of water, instead of producing the heaviest fruit yields, resulted in such an excessive wood growth that the fruit was small and poorly colored and flavored. A bulletin published during the year treats of cultivation, shading, quantity of water applied, surface and subirrigation, soil fertility, and soil texture as factors influencing evaporation and transpiration.

The drainage work of the station, also in cooperation with this office, was carried on as formerly outlined. It has resulted in the reclamation of large tracts of land in different parts of the State and in the formation of a number of drainage districts. In two instances where the original drainage systems proved to be failures further investigation solved the difficulties and later drains reclaimed the land in question. The results of this work are in preparation for publication.

Arid farming experiments were continued, and the remarkably dry and hot season gave opportunity for the more critical testing of varieties and of methods than anything previously experienced. On most of the dry-farm areas of the State less than 1 inch of rain fell during the entire grain-growing period, and yet fair yields were obtained where the best methods were employed. This work is principally carried on at the substations maintained by the station at Nephi, Monticello, and St. George.

The veterinary department continued its studies on bighead of sheep in cooperation with the Bureau of Animal Industry. The department also studies outbreaks of diseases of anthrax in the State.

Ornithological studies were confined to the food habits of the mourning dove and other birds and the preparation of the observations for publication.

Considerable extension work was done by the college, and the station contributed to this movement. Ten movable schools of one week's duration were held during the year and more than double that number of farmers' institutes. One demonstration train, taking up the special topics of potato growing and orchard heating, was run over the Oregon Short Line within the State.

The following publications were received from this station during the fiscal year: Bulletins 105, Irrigation Investigations: Factors Influencing Evaporation and Transpiration; 106, A Study of the Production and Movement of Nitric Nitrogen in an Irrigated Soil; 107, Improvement of Utah Horses; and 108, The Effect of Formalin on the Vitality of Seed Grain.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation	13,554.94
Farm products.....	3,667.81
Balance from previous year.....	471.40
Total	45,694.15

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedule prescribed by this department and has been approved.

The work of the Utah station has been considerably broadened by the aid of State appropriations, and in some of its departments is quite actively pursued.

VERMONT.

Vermont Agricultural Experiment Station, *Burlington*.

Department of University of Vermont and State Agricultural College.

J. L. HILLS, Sc. D., *Director*.

The affairs of the Vermont station, as in the previous year, were marked by numerous changes in the station staff. No changes were made in the equipment and endowment of this station during the year.

Work on some of the Adams-fund projects undertaken by the station was pursued actively, while other investigations of this class, owing to numerous changes in the staff during the last two years, were held in abeyance. In studying the forcing of plants with carbon dioxid, special attention was given to radishes and lettuce. Experiments on the relation of size of seed to the future plant were continued in the field with a number of horticultural crops, and records were kept of the resulting plants with regard to flowering, fruiting habits, quality and quantity of product, and similar points. The project on the breeding of carnations was practically completed and the results made ready for publication. The study of disease resistance of potatoes was continued in cooperation with this department. The results secured in studying anesthesia of dormant plants were published and the project was closed. The results thus far secured in the investigation on the general principles involved in the production of double-flowering plants were also prepared to be published.

The data collected in connection with the work on the damping off of coniferous seedlings, together with the work done by Prof. L. R. Jones on the potato-disease project, were prepared for publication. The project on the micro-organisms of maple sap and sirup was continued and last year's results were published. A relatively large amount of work was done on the storage of sugars and other carbohydrates in the maple. Different parts of the tree were analyzed for the determination of sucrose, moisture, sugar, starch, hemicelluloses, and ash. A large amount of data and definite results were secured in this study.

Experiments on the nutritive value of milk were conducted with pigs of different breeds, being fed milk containing different amounts of fat. Experiments with milk homogenized with corn oil were under way. Apparently there is a difference in fat consistency

which has an important effect on the nutritive value of the milk. A large amount of chemical work was done, including analyses of blood, internal organs, skeletons, and meat. Marked chemical differences in the fat of the animals fed in different ways was observed. The strength of the bones was also tested. The project on the effect of feeding different amounts of digestible protein to cows for a long period was conducted on the same plan as heretofore.

Under the Hatch-fund work was pursued in horticulture on apples, including tests of varieties, a study of grafts from productive and nonproductive trees of different varieties, scion selection, and other problems of a like nature. Field experiments were made in the crossing of cucumbers, including a study of unit characters. Experiments were also made with strawberries, including breeding by selection and in growing plants in pots and transplanting them to the field so as to give fruit the first season after transplanting.

The chemist published results obtained in studies on the availability of organic nitrogen, continued work in cooperation with the Rhode Island and Connecticut stations on a method for showing the availability of nitrogen in commercial fertilizers, and gave attention to the control work of the station in the same way as heretofore.

The dairyman completed experiments in making ice cream and published a bulletin setting forth the results. Experiments on the manufacture of cottage cheese were also made.

The work in forestry, which was in charge of the State forester, included the material enlargement of the forest-tree nursery, the publication of a bulletin on forest fires, the preparation of one on methods of cutting, and the making of experimental plantings.

In addition to the cooperative work already mentioned, the station completed its work, carried on with the New York station at Geneva, on the bacterial soft rots of certain vegetables, the results being published at some length in Bulletin 147 of the station. With this department the station cooperates in the Morgan horse-breeding enterprise at Middlebury and in the study of *Phytophthora* and disease resistance in potatoes. Some of the station officials made addresses during the year at farmers' institutes and other agricultural gatherings, but no definite policy of extension work was pursued.

The following publications were received from the station during the year: Bulletins 142, Plant Diseases—Potato Spraying; 143, Commercial Fertilizers—The Service of a Fertilizer Control—Soil Physiography; 144, Feeding Stuffs Inspection—Concerning Commercial Feeding Stuffs; 145, Vermont Shrubs and Woody Vines; 146, The Grass and Clover-seed Trade in Vermont in 1907–1909; 147, The Bacterial Soft Rots of Certain Vegetables; 148, A Bacterial Soft Rot of Muskmelon, Caused by *Bacillus melonis* n. sp.; 149, A Practical Method of Killing Witch Grass; 150, The Rôle of Anesthetics and

Other Agents in Plant Forcing; 151, "Buddy Sap;" Circular 3, Concerning Work Which the Station Can and Can Not Undertake for Residents of the State; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation-----	4,441.07
Fees -----	3,145.09
Farm products-----	6,187.13
Total-----	41,773.29

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

Although numerous changes in its staff interfered with the work of the Vermont station, many of its lines of work were prosecuted actively and the endeavor of the station to serve the public principally through the scientific investigation of matter pertaining to the agriculture of the State was steadfastly maintained.

WASHINGTON.

Washington Agricultural Experiment Station, Pullman.

Department of the State College of Washington.

R. W. THATCHER, B. S., M. A., *Director*.

The changes on the staff of the Washington station during the year, which were otherwise largely confined to the secondary positions, included the resignation of G. Severance as agronomist and the appointment of L. Hegnauer as his successor and the granting of indefinite leave of absence to C. W. Lawrence, the cerealist, and the appointment of A. Carlyle to take charge of the cereal work.

At the western Washington Experiment Station at Puyallup a new building with a small greenhouse attached was erected by the State at a cost of \$4,500. The State appropriation for this station is about \$30,000 for the biennium. The work included studies of diseases of the blackberry and the raspberry, breeding experiments with these fruits to improve their quality and their resistance to crown gall and anthracnose, tests with forage crops adapted to furnishing succulent dairy feed for cattle, tests with vegetable crops and small fruits, and poultry management. In working on the crown gall of the blackberry a bacterial organism, which appears to be the causative agent, was isolated.

The Adams-fund work on the improvement of the yield and the chemical composition of cereals was continued with selected hybrid

grains. Wheats collected for this work from different localities, typical as to soil and climate, were studied in detail with reference to their milling and baking qualities. Different factors, including chemical reagents and the high and low nitrogen content of wheat in their relation to the baking qualities, were studied, and an investigation of the variation in quality of individual wheat kernels in the head was made.

The study of the function of sulphur as a plant food was taken up during the year. Peas and wheat were grown in pot tests on different types of soil and supplied with sulphur in different forms to determine the influence upon growth and chemical composition. Work on the soil-moisture project was carried on with wheat grown in pots on different types of soil, and several important relationships of soil moisture on the production of the dry matter in the plant were studied. The field work on this project included investigations on the conservation of water as affected by different soil treatments and on the factors influencing the loss of moisture by evaporation.

The study of starch production by the potato, which was interfered with by frost injury to the material secured the year before, was again taken up actively, further material being collected and selections made. A good cellar was provided during the year where the tubers can be safely kept.

Attention was further given to the tomato-blight project—a study of a new disease, the study of soil toxicity resulting from the growth of coniferous trees, including its influence on root respiration, the effect of nutrition on the development, maturity, and prolificacy of swine, the investigations on Mendelism in blackberry hybrids, the effect of parasitism on the host insect, and to some extent to hemoglobinemia in cattle. The work on the destruction of spermophiles by means of a disease was concluded. The disease, while effective in killing infected squirrels, failed to spread satisfactorily.

The Hatch fund was used for the support of a number of other lines of work in addition to those enumerated. The plant pathologist studied different varieties, and in particular the station's selections with reference to their susceptibility to wheat smut, and also gave attention to a bacterial disease of tomatoes.

The assistant zoologist worked on the life history of the Columbian ground squirrel with a view to finding methods for its extermination, and gave special attention to the peculiar hibernating habits of this animal and their relation to food and moisture. This line of work for the coming year is to be conducted as an Adams-fund project.

Feeding experiments were carried on with horses to determine the feeding value of timothy, wheat, and alfalfa hays used with oats and barley. In a feeding test with cows, alfalfa meal proved cheaper

and gave slightly better results than the use of molasses and barley meal. Some work was also done on steer feeding.

The Department of Agriculture continued the rotation and tillage experiments, which are followed under a permanent plan, together with improvement work on cereals and forage plants. The principles of breeding were studied and considerable data on the subject were collected. Five-year variety tests with corn in cooperation with this department were completed during the year and the results prepared for publication. Cooperative work with this department was also followed in variety and culture tests with field peas. Attention was further given to growing soy beans and field beans in place of summer fallowing land. It is estimated that the hybrid wheats, originated and distributed by the station for the past four years, resulted the past season in an increase of 1,500,000 bushels in the production of wheat.

The horticultural department pursued work on orchard tillage and cover crops, vegetable-seed production, and ornamental plants, and gave attention to the introduction and adaptation of a great number of fruits and to the effect of different systems of pruning on the color of orchard fruits. The veterinary department gave special attention to a study of anemia in horses, of which an outbreak occurred in the State.

The farmers' institute and extension work during the year covered a wider range than was ever before attempted. O. M. Olson, deputy superintendent of farmers' institutes, resigned, and the vacancy was filled by the appointment of R. C. Ashby as assistant superintendent of farmers' institutes, who entered upon his work in May, 1910. A new feature was introduced by the establishment of demonstration farms under the supervision of H. W. Sparks, appointed supervisor of demonstration farms, beginning July 1, 1909. Ten such farms were in operation during the year 1910. The several railroad companies operating lines within the State showed a very active interest in, and gave assistance to, the extension work of the college and station.

The following publications were received from this station during the year: Bulletins 89, The Hybrid Wheats; 93, A Preliminary Report on Some Experiments in Clearing Logged-off Land with a Stump Burner—A Promising Method for Destroying Stumps and Logs; 95, Chou Moellier or Marrow Cabbage; 96, Hatching and Rearing Turkeys by Artificial Methods; 97, Anthracnose of the Blackberry and Raspberry; Popular Bulletins 17, A Single Spray for the Codling Moth; 18, Growing Blackberries and Raspberries in Washington; 19, The Use of Fertilizer Lime; 20, Summary of Experiment Station Work; 21, Experiment Station's Hybrid Wheats; 22, Tillage in its Relation to Soil Moisture; 23, Trees in Washington;

24, The Pruning of Apple Trees; 25, Gooseberries for the Home Garden or Commercial Orchard; 26, Currants for the Home Garden or Commercial Plantation; 27, Spraying Calendar for 1910; 28, The Sulphur-lime Wash; Bulletin 1 (special series), An Experiment in Clearing Logged-off Land by the Aid of a Donkey Engine in 1908; and the Annual Reports for 1906, 1907, and 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation-----	26,896.00
Farm products-----	13,224.87
Total-----	68,120.87

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Washington station is in good condition and efficiently managed. An earnest effort is being made to meet the needs of, and through its extension department to carry its results to, the farmers. Funds for printing popular bulletins would be of material assistance in this connection.

VIRGINIA.

Virginia Agricultural Experiment Station, Blacksburg.

Department of Virginia Agricultural and Mechanical College and Polytechnic Institute.

S. W. FLETCHER, Ph. D., *Director*.

There were few changes in organization, personnel, or lines of work at the Virginia station during the year. The departments of animal husbandry and veterinary science were consolidated under the charge of N. S. Mayo, who came to the institution at the beginning of the year. W. A. P. Moncure, in charge of the investigation of horticultural by-products, resigned about the close of the fiscal year. The station was given a larger share in the management of the work of various substation and cooperative enterprises in the State. With the \$5,000 appropriated annually for substations in tobacco districts, six substations have been established under the management of an agricultural board on which the station has representation. By agreement with the State board of agriculture, the institution supervises experimental work at Staunton and Saxe. The last legislature appropriated to the station \$5,000 for the year 1911 for the establishment of district experiment stations, and steps were taken to this end.

Substantial progress was made in several of the Adams-fund projects pursued by the station, while others received little or no

attention. A large amount of work was done on the fixation of phosphoric acid by soils, and the investigations on this subject were extended to include cylinder experiments with four typical soils of the State. The object of the work is to determine the conditions under which fixation and the consequent unavailability for plant growth take place. Some of the studies on soil bacteria conducted during the year included the infection of root hairs by means of *Bacillus radicum* and some of the involution forms, the fixation of nitrogen by means of *Pseudomonas radicum* without the presence of a leguminous plant, and the experiments on denitrification which were brought to a close.

Investigations on curative treatment of tuberculosis in cattle were continued, and the work was supplemented by an investigation on the transmission of tuberculosis to hogs when they are fed on skim milk from diseased animals and under other conditions. This work is conducted in cooperation with this department. A considerable amount of work was also done on the behavior of grazing lands under various methods of treatment. This was also carried on in cooperation with this department and with several farmers. Some very striking results were obtained with reference to the effect of light and heavy grazing upon the amount and character of the vegetation. In this connection attention was also given to breeding better strains of pasture grasses and especially of blue grass.

The endeavors to produce from pure-bred and cross-bred seedlings a group of commercial apples blooming so late that the danger of frost injury is reduced were continued during the year, and progress was made. Many of the seedlings secured are now ready for top-working upon dwarf stocks. Incidental to this problem the effect of temperature upon the blooming of fruit was investigated, and basal data showing the value of different temperatures were secured by bringing fruit buds to bloom under temperature control in incubators. The fermentation studies showing the possibility of controlling fermentation by means of selected yeasts were completed, and the final results were prepared for publication.

Some important studies of variations in bud formation were made and reported upon during the year, and observations on the influence of meteorological conditions on bud development were continued. The investigations on relation of parasitic fungi and bacteria to their host plants were along the line of enzym formation and action in relation to plant diseases, such as cabbage black rot, bitter rot of apples, and tomato Fusarium.

In addition to the Adams-fund investigations, the different departments of the station conducted experiments along a number of other lines. The chemist had in progress a series of laboratory, pot, and

field experiments to determine the fertilizer requirements for the principal soil types of the State. The investigation of the nutritive value of various Virginia grasses and forage plants was continued, together with a study of the lime resources of the State and the comparative value of ground limestone and burnt lime for liming land.

The horticulturist continued the studies of inheritance in garden vegetables with particular reference to Mendel's law. The work with tomatoes was completed and reported upon in Bulletin No. 177 of the station, and various cruciferous vegetables were placed under observation. The influence of soil environment on fruit bud formation was studied with dwarf fruit trees grown in pots and in cylinders sunken into the ground. Preliminary to this work a very thorough study was made of the history of fruit-bud formation in all the common orchard fruits, the period covered being from July 1 to the blooming period of the following year. Other work included varietal studies of orchard fruits, fertilizer experiments with apples, a test of the commercial culture of dwarf apples, and an experiment in the culture of basket willows carried on in cooperation with this department.

The department of agronomy continued the improvement work of varieties of corn, wheat, oats, and potatoes most commonly grown in Virginia, and made a study of the acclimatization of corn. The effort to increase the sugar content of sweet corn to make it more valuable for canning gave encouraging results. The tobacco work included plat experiments with fertilizers, crop rotation, demonstration plats, and tobacco breeding to produce the best and most productive strains of seed for the locality. Other work of this department included plat tests of various grasses, forage crops, fertilizers, and crop-rotation experiments.

The animal husbandry department completed an experiment on the most economical use of silage in steer feeding, and continued to test various substitutes for milk in feeding calves. A study was also made of the methods and results of beef production in the State. The dairy department completed observations on the production of sanitary milk, the results being published in Bulletin No. 185 of the station. In addition, the efficiency of farm separators, the milk supply of cities, and the study of ice-cream fillers received attention.

The department of plant pathology, working in cooperation with this department, made a preliminary survey of the prevalence of diseases of economic plants in the State, and made special investigations of an undescribed disease of tomatoes, black rot, and club-foot of cabbage, and spinach diseases. The experiments on cabbage were conducted in cooperation with growers and those with spinach in cooperation with the Virginia Truck Station.

The following publications were received from this station during the year: Bulletins 182, Silo Construction; 183, Work at the Tobacco Stations; 184, Impurities of Grass and Clover Seed Sold in Virginia; 185, Clean and Sanitary Milk; 187, Lime for Virginia Farms; 188, The Use of Lime-sulphur Preparations in the Summer Spraying of Virginia Apple Orchards; and Circular 7, rev., Fighting the Insect Pests and Diseases of Orchard, Field, and Garden Crops.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
State appropriation, including balance from previous year -----	8,000.40
Individuals -----	5.00
Farm products -----	2,706.75
Miscellaneous, including balance from previous year--	519.63
Total -----	39,231.78

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Virginia station conducted successfully a large amount of well-organized, scientific investigation in agriculture, and endeavored to make the results of this work practically applicable to the varied agricultural conditions of the State. A permanent State appropriation for the general use of the station is essential if the demands for extension work are to be properly met.

Virginia Truck Experiment Station, Norfolk.

Cooperating with the Virginia Agricultural Experiment Station and the United States Department of Agriculture.

T. C. JOHNSON, B. S. Agr., M. A., *Director*.

At the Virginia Truck Station a spray laboratory and tool house and a cottage residence were added to the station buildings during the year. C. S. Heller, assistant horticulturist, resigned, and P. T. Cole was appointed to take his place. F. A. Johnston of this department was assigned to work with this station, and L. L. Corbett was appointed assistant in truck crops.

The principal investigations and experiments carried on during the year included a study of the influence of certain commercial fertilizers on truck soils and truck crops, truck-crop rotations, plant breeding, control of truck diseases, control of truck-crop insects, and the irrigation of truck crops. The station worked out methods of controlling insects affecting certain crops in the seed bed.

Cooperative work in spraying was carried on with farmers in the immediate vicinity. Other lines of cooperative work included investi-

gations in vegetable pathology, plant breeding, and entomological work in cooperation with this department, and work on spinach diseases in cooperation with the Virginia station.

The director of the station assisted the State department of agriculture in various farmers' institutes in the trucking section of the State.

The publications of the station received during the year were as follows: Bulletins: 1, The Control of Malnutrition Diseases; 2, Some Insects Injurious to Cabbage, Cucumbers, and Related Crops; and 3, Some Seed-potato Questions in 1909.

The income of the station during the past fiscal year was as follows:

State appropriation	\$5, 000
State board of agriculture and immigration.....	5, 000
Total	10, 000

The practical and cooperative work of the Virginia Truck Station can not fail to be of great value to the locality and the particular branch of agricultural industry which it is intended to serve.

WEST VIRGINIA.

West Virginia Agricultural Experiment Station, *Morgantown*.

Department of West Virginia University.

J. H. STEWART, M. A., *Director*.

During the year W. M. Munson, horticulturist of the station, resigned his position on account of illness, which was followed later by his death. C. M. Gifford was elected assistant plant pathologist. Important additions to the equipment of the station dairy and the station laboratories and especially for soil and bacteriological work were made. The State provided \$6,000 for orchard inspection and spraying demonstrations, and \$4,000 for truck-crop investigations during the year.

In general the Adams-fund projects were continued as originally outlined, but work on the horticultural project, owing to the illness of the horticulturist, was confined to the planting of two apple nurseries and the supervision of the apple and peach orchards secured for this investigation. The studies on the effect of high pressures on fruits and fruit juices were about completed, and work was begun on an investigation of the artificial fixation of atmospheric nitrogen by means of electrical discharges.

In connection with the project on the production of sanitary milk, it was found that the bacterial content of the milk is very greatly increased by the usual method of artificial cooling in an open room.

A cooling apparatus was devised by means of which it is possible to produce cooled milk with no appreciable increase in its bacterial content. Studies were also pursued regarding the bacterial flora of milk in the udder and the means of controlling it.

Progress was made in the study of the cucumber mildew and of apple-leaf diseases. Twelve distinct species of fungi were isolated from apple leaves and their life histories were worked out. The study of the stages not fully established in the life history of the woolly aphis of the apple was continued, and a report of progress on the investigation of snout beetles injuring nuts was made in the form of a bulletin. The list of these nut-attacking beetles studied was as follows: *Balaninus proboscideus*, *B. rectus*, *B. caryæ*, *B. obtusus*, *B. quercus*, *B. nasicus*, *B. orthorhynchus*, *B. baculi*, *B. confusor*, *B. pardalis*, *Conotrachelus juglandis*, *C. affinis*, *C. naso*, and *C. posticatus*. Some data were collected in connection with the studies of the short-tailed shrew.

Work on the project regarding the mortality of brooder chicks included studies of the influence of age of fowls, temperature of brooder, aeration, moisture, heavy feeding, length of laying period, and other similar factors on the vigor of the egg sperm. A project involving the study of acidity in soils, largely with reference to the factors tending to produce soil acidity and those which either increase or decrease the acid condition of the soil, was submitted and approved.

The activities of the station supported by Hatch and other funds were also pursued on a project basis. Fertilizer requirements of the soil on the station farm were studied, and the effect upon the physical properties and chemical composition of the soil of long-continued applications of different manurial substances, including lime, stable manure, sodium nitrate and acid phosphate, was noted. Observations were further made on the relative yields of the standard farm crops when fertilized in the various ways. As a result of the work on acid soils the application of lime and the culture of clover and cowpeas have greatly increased throughout the State. Other results confirm the station's position that the use of the commercial acid phosphates is not responsible for acid soils in West Virginia.

The department of agriculture conducted tests of types of poultry houses as affecting health and productivity of laying hens, and studied the effect of artificial methods of rearing poultry on the vigor and productivity of the flock. This test has been in progress without interruption for 10 years. This department also carried on feeding experiments with fowls, continued the plat work begun in 1900, and carried forward the improvement of the old farm, which has now been brought up to a condition enabling it to furnish all the forage required by the station.

The horticultural department gave attention to disease-resistant stocks for the Grimes Golden apple for the purpose of overcoming the short-lived character of this variety and to the determination of methods and practices which will enable the continuous growing of peaches with profit upon the same land. A series of experiments was carried on in cooperation with growers on the use of fertilizers for orchards, potatoes, and tomatoes, and a study was made of the most profitable means of disposing of the poorer grades of apples. Observations were made on the effect of soluble oil sprays on the growth of young apple trees and on the use of lime of different purities in the preparation of spray mixtures. Demonstrations were conducted in a number of counties of the State in cooperation with farmers and orchardists for the purpose of stimulating the practice of spraying fruit trees.

The entomologist continued comparative tests of eastern and western methods for controlling the codling moth, and made a preliminary report on the work. Thus far the results show that the so-called high-pressure western method of combating the codling moth is not superior to the method in general use in the East. A study was also made of a serious attack of walking sticks on peach orchards and data were collected on a brood of periodical cicada due this season. Attention was further given to wasp epidemics and the natural enemies of these insects.

The work of the station supported by State funds comprised the official enforcement and administration of the State laws concerning commercial fertilizers, studies on the effectiveness of Bordeaux-arsenate mixtures in controlling diseases of the potato, experiments in the growing of edible mushrooms in worked-out coal mines, investigations concerning the tomato-canning industry in the State, including extensive variety tests, fertilizer experiments on young and bearing orchards, and tests of Jersey, Ayrshire, and Kerry cattle and their crosses with regard to their adaptability as dairy animals under West Virginia conditions. A record was kept of the milk production of these different dairy breeds, together with the percentage of fat and the weight of the animals.

Among other miscellaneous lines of work followed by the station may be mentioned the inspection of grain and grass seed, bacteriological analysis of waters, fertilizer and insecticide control work, and the improvement of the incubator. The inspection of orchards and the devising and enforcement of means for the control and destruction of orchard pests were continued with increasing beneficial effects upon the horticultural industry of the State, and was supported by a special State appropriation for the purpose. Cooperative work with farmers consisted chiefly in the continuation of efforts to determine the best method of exterminating internal parasites of sheep,

in tests of herds for tuberculosis, and in the use of hog-cholera serum. Members of the station staff also took part in farmers' institute work and attended other similar gatherings.

The following publications were received from this station during the year: Bulletins 119, The Grape-cane Gall Maker and the Grape-cane Girdler; 120, Cabbage Worms, and Suggestions for Destroying Them; 121, Apple Enemies, and How to Fight Them; 122, The Farmer's Home Garden; 123, Diseases of Garden Crops and Their Control; 124, Some Factors Influencing the Vigor of Incubator Chickens; 125, Commercial Fertilizers; 126, Three Snout Beetles that Attack Apples; 127, Spraying for the Codling Moth; and 128, Snout Beetles that Injure Nuts.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	13,000.00
State appropriation.....	10,000.00
Fees.....	13,506.84
Farm products.....	6,500.89
Miscellaneous.....	77.38
Total.....	58,085.11

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The West Virginia station is carrying on a number of lines of important work and is receiving the encouragement and support of the State in strengthening and broadening its influence.

WISCONSIN.

Agricultural Experiment Station of the University of Wisconsin, *Madison*.

Department of the University of Wisconsin.

H. L. RUSSELL, Ph. D., *Director*.

The past year at the Wisconsin station was marked by an active prosecution of the different lines of research and investigation in hand. Changes in the personnel of the station staff were few. Among them may be mentioned the promotion of J. G. Moore, who was placed in charge of the organization of the work in horticulture, the appointment of C. E. Lee as assistant in dairying, and of F. B. Hadley in charge of the veterinary-science work of the station. In addition, several other resignations and appointments in the corps of assistants took place.

A number of improvements and additions to the resources of the college and station were made during the year. Additional facilities

were provided for the dairy department by the construction of a two-story and basement building (Pl. VIII, fig. 1) to afford additional laboratory space. The new equipment for the poultry department includes a general-utility building, breeding pens, portable colony houses, and a breeding house of modern design and construction (Pl. VIII, fig. 2). The agricultural buildings were connected to a new central heating station, and the old heating plant was turned over to the dairy department to furnish increased facilities for its different lines of work. Quarters for the newly organized departments of experimental breeding and veterinary science were assigned in the new stock pavilion, which was erected during the preceding year, and laboratory facilities for these departments are in process of construction. The interior of the soils building was remodeled, and it was decided to construct entirely new quarters for the horticultural department, which occupied space in the soils building. In order to prevent interference with the work of the horticultural department, four greenhouses connected with a one-story and basement brick structure were erected. In addition to these a small pathological laboratory was constructed for the department of plant pathology. Miscellaneous farm buildings, erected at the university and Hill farms, included a two-story litter shed and sheds for housing wagons, implements, and machinery. A concrete silo (Pl. IX, fig. 2) was built on the Hill farm with a new type of mold devised by the agricultural engineering department.

The legislature of 1909 passed an act permitting the establishment of two permanent branch experiment stations, and steps were taken toward the establishment of one of these stations on an 80-acre tract of land adjacent to the town of Spooner, in Washington County. The work to be attempted there will be largely soil improvement. For this same purpose a demonstration substation was started at Ellis Junction, in Marinette County. The reclamation of marsh lands on the university farm, undertaken this year, will add greatly to the land resources of the institution.

Work on all the Adams-fund projects of the station was actively pursued. The study of the mineral requirements of growing animals, conducted cooperatively by the agricultural-chemistry and animal-husbandry departments, was continued principally along the line of the influence of the lime supply on the development of the skeleton of the progeny. It appeared that the skeleton development of the young as to lime content, as well as size, is maintained in the pigs regardless of the character of the lime supply present in the food. The lime was fed in these experiments in the form of ground limestone or calcium carbonate, as floats or calcium phosphate, and in ground alfalfa. The floats proved superior to the ground limestone, which did not serve so well in making bone or in retaining the phos-



FIG. 1.—DAIRY LABORATORY BUILDING, WISCONSIN COLLEGE AND STATION.



FIG. 2.—BUILDINGS OF THE NEW POULTRY PLANT, WISCONSIN COLLEGE AND STATION.



FIG. 1.—NEW DAIRY BARN, SOUTH DAKOTA COLLEGE AND STATION.



FIG. 2.—CONCRETE SILO AT THE WISCONSIN COLLEGE AND STATION.

The station is giving advice and other assistance to farmers to encourage cooperative silo building of this type.



FIG. 1.—COW FED WHOLLY ON CORN PRODUCTS, SHOWING GOOD CONDITION AND THRIFTINESS.



FIG. 2.—CALF FROM COW FED ON CORN PRODUCTS, ACTIVE AND VIGOROUS AT BIRTH.

EFFECT OF EXCLUSIVE FEEDING OF WHEAT PRODUCTS AND OF CORN PRODUCTS, WISCONSIN STATION.

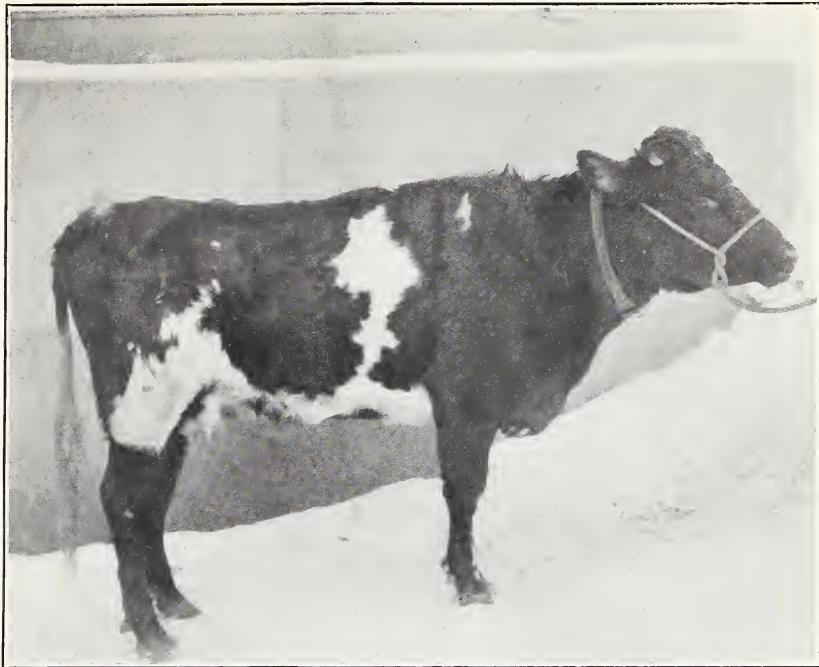


FIG. 1.—COW FED WHOLLY ON WHEAT PRODUCTS, SHOWING GENERAL UNTHRIFTY APPEARANCE.



FIG. 2.—CALF FROM 'COW FED ON WHEAT PRODUCTS, TOO WEAK TO STAND AT BIRTH.

EFFECT OF EXCLUSIVE FEEDING OF WHEAT PRODUCTS AND OF CORN PRODUCTS WISCONSIN STATION.



phate fed in grains or clovers. The experiment will be conducted through several generations to confirm these results.

In the comparison of nutrients from single-plant sources and from different plants on the development of cattle, it was observed that while the rate of growth was not greatly dissimilar, the physical conditions of the different groups varied widely. The animals in this experiment were reared on a ration balanced in accordance with the regularly accepted standards, but derived from single-plant sources—wheat, oats, corn, and a mixture of the three. The lots fed corn and its products continued thrifty and gave large, strong progeny (Pl. X); while those fed on the products of wheat alone showed low vitality, low milk production, and weak, under-sized calves (Pl. XI). The oat lot gave results more nearly like the corn lot, while those fed equal parts of corn, wheat, and oats resembled more nearly the wheat-fed animals. It was further found that a mature corn-fed animal can not be changed to a wheat ration without resulting shortly in death, while a wheat-fed animal can pass to a corn ration with improvement. The study of the rôle of acid in cheese production showed that by the use of commercial acid time may be saved without diminishing the quality of the cheese. To overcome defects in the milk, however, pasteurization was resorted to, and the combination of pasteurization and the use of commercial acid was found to bring the milk into uniform condition as to bacterial content and acidity. The absolutely uniform process gave greater reliability and uniformity of product and eliminated to a certain extent the skill of the maker. After this method was established a test for a long period on a factory scale was inaugurated. It was further shown that the cheese made by this process may be cured at the temperature of the ordinary uncooled curing room. Curing at a medium or warm temperature gave better results than curing in the cold.

Investigations continued by the dairy department on the purification of creamery and cheese factory sewage led to the conclusion that such sewage can be thoroughly reduced if the material can be held for a sufficient period of time in a closed septic tank. The decomposition processes in the tank do not completely purify the sewage, but render it sufficiently soluble for ready purification when turned intermittently onto sand or soil.

The work on the loss of phosphorus on heavily manured soils, as is especially found in tobacco, asparagus, and cabbage culture, was continued. Marked losses in the leaching of soluble phosphates were observed, showing that the excess of phosphorus did not accumulate in the soils under test. The results of studies on the forms of phosphorus in the soil showed that nearly one-half of the soil phosphorus is bound up with organic matter in such a way as to render

it insoluble. Methods were devised for the differentiation of the soluble from insoluble phosphorus.

A number of different lines of work were also carried on with Hatch and miscellaneous funds. The influence of sulphur on wool production was studied cooperatively by the departments of agricultural chemistry and animal husbandry. The object of this work is to determine whether or not a casual relation exists between the form and amount of sulphur supplied in the feed and its relation to the growth of wool. Incidentally, results showed that our farm feeds contain greater quantities of sulphur than has been supposed, and it is suggested that the low results which have been previously reported are due to faulty analytical methods. On the basis of existing analyses, it was considered that a 100-bushel corn crop would remove only about one-fourth of a pound per acre, whereas the analytical methods devised in this work showed that the actual loss is about 8 pounds.

The veterinary department of the station was forced to give considerable attention to an anthrax outbreak occurring on the university farm. In this connection the susceptibility of swine to this disease was observed, and it was found that the general opinion that hogs do not acquire anthrax unless fed on anthrax-infected carcasses is erroneous, as the death of the hogs in the cases under observation must have come from soil infection. The lesions upon post-mortem examination were found far from typical, and without a microscopical examination would not have been regarded as anthrax from a clinical point of view. In experiments with young pigs the disease was not produced by infection through feeding, even where laceration of the mucous membrane of the mouth was produced, nor by cutaneous inoculation, but with subcutaneous injection young pigs succumbed.

The chemist continued his studies on the relation of "metabolic" water produced in tissues to the growth of plants and animals. It was shown that the action of this "metabolic" water plays an important part in the germination of seeds. Observations made upon various insects, such as clothes' moths and grain weevils, which subsist entirely upon air-dried material containing less than 10 per cent of water, indicate the presence of over 50 per cent of water in their tissues.

The improvement work on existing varieties of fall rye, spring and winter wheat, carried on by the agronomy department, has resulted in a marked improvement in yield and uniformity. Last year the pedigreed barleys were disseminated through the Wisconsin Experiment Association. The new varieties of wheat and rye on the station farm show a marked increase in yielding capacity over ordinary sorts. The yield of pedigreed oats No. 4 on the station

farm was 76 bushels per acre. Much of this work is carried on at the substations in the northern part of the State.

The horticultural department gave special attention to the study of seedling apples, the introduction of new varieties of apples, rhubarb forcing, tomato breeding, tobacco breeding, and culture experiments and fruit trials. A successful method was developed for securing suitable roots for forcing rhubarb. In the tomato-breeding work strains resistant to the mosaic disease have been obtained, and efforts are now centered on the improvement of the type of fruit formed. The tobacco-breeding work is now centered on the further improvement of the type of seed by hybridization. The tobacco cultural work bore generally on the use of cover crops, the application of commercial fertilizers as compared with barnyard manure, and the use of tobacco as a tilled crop in rotation. The fruit trials were conducted cooperatively near Bayfield, a region favored by virtue of its location, climatic conditions, and soil. The object of these trials is to determine the varieties of apples, cherries, plums, and other fruits adapted to the locality.

In the organization of the work of the new plant pathology department attention was given to making a plant-disease survey of the State, and, incidentally, observations were made on the tip burn of the leaves in potatoes, scab, fire blight, and sun scald of apples, and pathological conditions due to physiological as well as parasitic causes in relation to cabbage, tobacco, peas, and ginseng, and other special crops grown continuously on the same land.

The entomological survey of the State showed that the San José scale had established itself at a considerable number of places in certain parts of the State.

Investigations in agricultural economics included historical and geographical studies with reference to the region of production of crops and kinds of live stock in each census period from 1840 to 1900, the study of farm tenures for the purpose of bringing together the results of experience on the best methods of renting farm lands, and making farm surveys to bring together the results of experience in farm management. The rural economist also maintained an advisory relation with the United States Census Office.

The cooperative work of the Wisconsin station included cheese work, the study of cranberry insects, the study of the history and geography of agriculture and farm-accounting investigations with this department, and work on the removal of stumps from cut-over lands in cooperation with this department and the Minnesota experiment station, making a State soil survey in collaboration with this department and with the State geological and natural history survey, and the preparation of a new Wisconsin dairy map in cooperation with the State dairy and food commission,

The inspection and control work of the station included nursery inspection, feeding stuffs, and fertilizer control, seed inspection, and the licensing of stallions.

The agricultural extension service of the college comprises tests of dairy cows, tuberculosis post-mortem demonstrations, butter and cheese scoring exhibitions, distribution of pure starters, dissemination of pure-bred seed grains, grain-growing contests, State and county farm demonstrations, potato-spraying demonstrations, orchard spraying work, planting of public grounds, tobacco seed distribution, drainage service, cooperative fertilizer tests, manure conservation tests, clover-hulling demonstrations, and exhibits at the State fair. The substations at Ashland, Iron River, and Superior, in the northern part of the State, also gave considerable attention to demonstration work in addition to other work along experimental lines.

The publications of the station received during the year were as follows: Bulletins 177, Potato Culture in Northern Wisconsin; 178, The Field Pea in Wisconsin; 179, The Eradication of Farm Weeds with Iron Sulphate; 180, Fertilizers for Wisconsin Farms; 181, The Propagation of Pure Starters for Butter and Cheese Making; 182, The Wisconsin Butter and Cheese Scoring Exhibitions; 183, Growing Clover for Seed and Forage in Northern Wisconsin; 184, Practical Swine Management; 185, Sanitary Cow Stalls; 186, Suggestions for the Improvement of Wisconsin Horses; 187, The University Dairy Herd, 1908-9; 188, Wisconsin Horse Breeding Statistics; 189, Community Breeders' Associations for Dairy Cattle Improvement; 190, Common Insect Pests of Fruits in Wisconsin; 191, A Decade of Official Tests of Dairy Cows, 1899-1909; 192, The Dairy Calf at Meal Time; 193, Report of the Director, 1909; 194, Licensed Commercial Feeding Stuffs, 1909; 195, New and Improved Tests of Dairy Products—The Preparation of Buttermilk Curd; Research Bulletins 1, The Rôle of Inorganic Phosphorus in the Nutrition of Animals; 2, Factors Influencing the Phosphate Content of Soils; 3, The Efficiency, Economy, and Physiological Effect of Machine Milking; 4, Some Conditions Which Influence the Germination and Fertility of Pollen; 5, The Rôle of the Ash Constituents of Wheat Bran in the Metabolism of Herbivora; 6, Studies on the Bacterial and Leucocyte Content of Milk; 7, Factors Controlling the Moisture Content of Cheese Curds; 8, Nuclein Synthesis in the Animal Body; 9, The Nature of the Acid-soluble Phosphorus Compounds of Some Important Feeding Materials; Circulars of Information 1, The Wisconsin Feeding Stuff Law; 2, The Propagation of Pure Culture Starters for Butter and Cheese Making; 3, Directions for Spraying Potatoes; 4, The Wisconsin Seed Inspection Law; 5, The Hollow Concrete Fence Post; 6, Synopsis of Wisconsin Drainage Laws, with Forms and General Suggestions; 7, The Agricultural Extension Service; 8, Corn Judging; 9, The Wis-

consin Dairy Cow Competition; 10, Operating the Casein Test at Cheese Factories; 11, Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1910; 12, Spraying the Home Orchard; 13, The Care of New-born Foals; 14, The Determination of Salt in Butter at the Creamery; 15, Analyses of Licensed Commercial Fertilizers, 1910; 16, The Culture and Storage of Root Crops; and the Annual Report, 1908-9.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15, 000. 00
United States appropriation, Adams Act-----	13, 000. 00
State appropriation -----	18, 500. 00
Fees -----	9, 296. 84
Total-----	55, 796. 84

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The Wisconsin station continues to pursue actively a high grade of research work along different lines, and to carry on a propaganda for the adoption of improved methods of practice as based on the results of the station experiments. The scope of its work is widening and the sphere of its influence includes all sections of the State and all phases of Wisconsin agriculture.

WYOMING.

Wyoming Agricultural Experiment Station, Laramie.

Department of the University of Wyoming.

H. G. KNIGHT, A. M., *Director*.

The principal change occurring on the Wyoming station staff was the resignation at the close of the year of Director J. D. Towar, who was succeeded by H. G. Knight, the station chemist. L. B. McWethy, the agronomist, retired from the station March 1, and his place was filled by T. S. Parsons. C. J. Oviatt was appointed assistant in the wool investigations. During the year a new barn, costing about \$5,000, was erected on the stock farm. A grain barn was completed and fitted up for cleaning, handling, and storing seed grains.

Work on the Adams-fund projects approved for the station was continued. In the wool investigations considerable attention was given to the development of proper methods for studying coefficients of variability, the breaking strain, elasticity, and other points regarding a scientific study of wool fiber. The study of environment on the character of wool was carried on with two flocks of sheep, one being kept in Ohio and the other in Wyoming. The feeding and

breeding problems connected with this work were also further investigated.

The work carried on in connection with the alkali investigations had for its purpose the study of the movement of alkali salts in terms of ionic changes, and an investigation of the effects of alkali upon seeds, with special reference to the laws governing the absorption of alkali by seeds. The investigation of woody aster, one of the poisonous plants affecting sheep, consisted in a study of the locations in the State where this plant is most common and in securing data as to the nature and extent of the losses. These field observations were preliminary to a study of the symptoms, physiological action, pathological lesions, and the toxic principles.

Under the Hatch fund the agronomist tested a number of selected and introduced varieties of plants with reference to their adaptability to the high-altitude conditions of the Laramie Valley. Alfalfa seed from different parts of the world was tested with a view of obtaining some improved individual plants adapted to the local conditions. Barley, oats, and wheat were grown from new and imported seeds, and selections in some cases were made from individual plants. Kherson and 60-day oats were found to be early maturing varieties and promising for high-altitude conditions. Among the varieties of winter wheat tested were Kharkov, Turkey Red, and Defiance. Among different varieties of spring wheat, some of them of Australian origin, a variety known as John Brown gave the most promising results. This variety yielded over 40 bushels to the acre and showed a much higher percentage of gluten and gave a much higher volume of loaf than Turkey Red.

Attention was also given to the culture of field peas as a forage crop in the Laramie Valley, and a bulletin, including results with garden peas, was published on these tests during the year. Other experiments by the agronomist included potato growing from selected seed; culture tests with root crops, with special reference to the value of fall and spring plowing, and the water requirements of the crops; fertilizer tests with barley; trials with sweet clover, brome grass, tall meadow-oat grass, meadow fescue, Italian rye grass, perennial rye grass, and orchard grass; culture experiments with alfalfa; and trials of crops under dry-farming methods.

The animal husbandman conducted feeding tests with lambs and cattle for the purpose of comparing the value of Wyoming grains with corn and of native hay and alfalfa in lamb production. Some breeding work was done with Polled Herefords and with sheep.

The work of the irrigation engineer included irrigation experiments on root and grain crops to determine the quantities of water necessary to secure maximum yields. In cooperation with the department of chemistry, measurements of the water-table fluctuations

in tile-lined wells, the amount of water with which the alkali tract was flooded, and the quantity passing the underground tile drains were made.

The chemical department continued its forage-plant investigation, together with the study of the effect of soil constituents upon the composition of plants.

The botanist assisted the department of chemistry in the collection and determination of the native forage plants for analysis, and also aided in the field work upon poisonous plants, principally the woody aster, which is studied as an Adams-fund project. Observations were made on woody and herbaceous ornamentals, and some experiments in tree and fruit growing were undertaken on the experiment farm.

The principal station work of the veterinarian consisted of practical work in caring for and treating the station stock.

Several of the station officers gave some of their time to farmers' institute work during the year. This work is maintained by a biennial State appropriation.

The publications of the station received during the year were as follows: Bulletins 81, Lamb Feeding for 1908-9; 82, Soil Nitrogen; 83, Barley; 84, Field Peas; and the Annual Report for 1909.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	13,000.00
Farm products -----	5,541.79
Balance from previous year, farm products-----	1,077.46
Total-----	<u>34,619.25</u>

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this department and has been approved.

The change in directors of the station has resulted in a thorough reorganization of the work and a strengthening of it in a number of directions. It has been more sharply differentiated from other activities, and the station administration as a whole put upon a much more efficient basis.

STATISTICS OF LAND-GRANT COLLEGES AND AGRICULTURAL EXPERIMENT STATIONS, 1910.

By Miss M. T. SPETHMANN.

The following statistical statements relate to the institutions established under the acts of Congress of July 2, 1862, and August 30, 1890, most of which maintain courses of instruction in agriculture, and to the agricultural experiment stations, which, with few exceptions, are organized under the act of Congress of March 2, 1887, and are conducted as departments of the institutions receiving the benefits of the land-grant act of 1862. These statistics have been compiled in part from the annual reports of the presidents of these institutions made on the schedules prescribed by the Commissioner of Education. Tables showing the annual disbursements on account of the acts of Congress of March 2, 1887, August 30, 1890, March 16, 1906, and March 4, 1907, prepared from figures furnished by the Departments of the Treasury and the Interior, are also included. Owing to the complex organization of many of the institutions, it is impracticable to give exactly comparable statistics in all cases, and in some instances the data furnished are incomplete.

SUMMARY OF STATISTICS OF LAND-GRANT COLLEGES.

Educational institutions receiving the benefits of the acts of Congress of July 2, 1862, August 30, 1890, and March 4, 1907, are now in operation in all the States and Territories except Alaska. The total number of these institutions is 67, of which 65 maintain courses of instruction in agriculture. The aggregate value of the permanent funds and equipment of the land-grant colleges and universities in 1910 is estimated to be as follows: Land-grant fund of 1862, \$13,361,616.86; other land-grant funds, \$3,012,781.84; other endowment funds, \$17,161,657.25; land grant of 1862 still unsold, \$9,185,818.22; farms and grounds owned by the institutions, \$15,838,518.42; buildings, \$42,578,301.92; apparatus, \$4,368,706.21; machinery, \$2,693,847.43; libraries \$4,378,389.04; live stock, \$602,644.57; miscellaneous equipment, \$4,330,706.83; total, \$117,512,988.59. The income of these institutions in 1910, exclusive of the funds received from the United States for agricultural experiment stations (\$1,271,200), was as follows: Interest on land-grant funds of 1862,

\$812,462.28; interest on other land-grant funds, \$143,044.29; United States appropriation under acts of 1890 and 1907, \$2,000,000; interest on endowment or regular appropriation, \$357,788.45; State appropriation for current expenses, \$7,178,109.19; State appropriation for increase of plant, \$3,504,873.22; income from endowment, other than Federal or State grants, \$759,806.77; tuition and incidental fees, \$2,176,637.80; private benefactions, \$1,791,864.72; miscellaneous, \$2,847,995.11; total, \$21,572,581.83. The value of the additions to the permanent endowment and equipment of these institutions in 1910 is estimated as follows: Permanent endowment, \$2,290,541.49; buildings, \$2,973,471.63; libraries, \$319,853.67; apparatus, \$396,878.58; machinery, \$261,634.93; live stock, \$134,959.30; miscellaneous, \$753,493.13; total, \$7,130,832.73.

The number of persons in the faculties of the colleges of agriculture and mechanic arts for white persons was as follows: For preparatory classes, including secondary schools of agriculture, 448; for collegiate and special classes in agriculture, 822; in mechanic arts, 880; and in all other instruction, 1,190; total, counting none twice, for interior instruction, 3,057. There were also 98 instructors in agricultural-extension departments, 1,239 experiment-station officers, and 2,920 persons in the faculties of other colleges or departments, making a grand total, counting none twice, of 6,409 persons engaged in instruction and research in the land-grant institutions.

The number of persons in the faculties of the colleges of agriculture and mechanic arts for colored persons was as follows: For preparatory classes, 124; for collegiate and special classes, 207; total, counting none twice, 290. In the other departments the faculties aggregated 122, making a grand total of 412 persons in the faculties of the institutions for colored persons.

The students in 1910 in the colleges for white persons were as follows: (1) By classes—preparatory, 6,921; collegiate, 26,411; post-graduate, 615; one to two year and winter courses, 9,100; summer courses, 2,518; total, counting none twice, in interior courses, 45,140. There were also enrolled in correspondence courses 30,075; in extension schools of five days or longer, not including farmers' institutes, 21,004; in all other departments of the institutions, 32,505; total number of students, counting none twice, receiving instruction from these institutions, 128,140. (2) By courses: Four-year—agriculture, including 168 in teachers' courses, 3,060; horticulture, 214; forestry, 340; veterinary science, 178; household economy, 1,617; engineering, 17,534. Shorter than four years—agriculture, 9,715; horticulture, 385; forestry, 156; dairying, 777; total, counting none twice, 10,733; veterinary science, 478; household economy, 1,695; teachers' courses in agriculture, 1,456 (one to three year, 192; summer schools of agriculture, 1,264); mechanic arts, 1,286; military tactics, 21,261.

The students in colleges and schools for colored persons were as follows: (1) By classes—preparatory, 4,589; collegiate, 1,382; short or special, 787; other departments, 633; total, 7,110. (2) By courses—agriculture, 1,331; teachers' courses in agriculture, 241 (one to four year, 151; summer schools, 90); industrial courses for boys, 2,523; industrial courses for girls, 4,836; military tactics, 2,025.

The graduates in 1910 in the institutions for white persons were as follows: Agriculture, 707; mechanic arts, 2,045; all other courses, 4,055; total, 6,807. The total number since the organization of these institutions is 87,328. The graduates in the institutions for colored persons were 435, and the total number since the organization of these institutions is 7,062. The total number of volumes in the libraries was 2,443,903, and the total number of pamphlets 636,667. The total number of acres of land granted to the States under the act of 1862 was 10,570,842, of which 979,467 are still unsold.

SUMMARY OF STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the acts of Congress of March 2, 1887, and March 16, 1906, in all the States and Territories, and under special appropriation acts in Alaska, Hawaii, Porto Rico, and Guam.

In Alabama, Connecticut, Hawaii, Louisiana, Missouri, New Jersey, New York, North Carolina, and Virginia separate stations are maintained wholly or in part by State funds. A number of substations are also maintained in different States. Excluding the substations, the total number of stations in the United States is 62. Of these, 55 receive appropriations provided for by acts of Congress.

The total income of the stations maintained under the acts of 1887 and 1906 during 1910 was \$3,537,700.25, of which \$1,344,000 (Hatch fund, \$720,000; Adams fund, \$624,000) was received from the National Government, the remainder, \$2,193,700.25, coming from the following sources: State governments, \$1,320,370.06; individuals and communities, \$16,468.61; fees for analyses of fertilizers, \$175,137.96; sales of farm products, \$277,502.82; miscellaneous, \$404,220.80. In addition to this the Office of Experiment Stations had an appropriation of \$349,220 for the past fiscal year, including \$28,000 each for the Alaska, Hawaii, and Porto Rico Experiment Stations, \$15,000 for the Guam Experiment Station, \$10,000 for nutrition investigations, \$75,000 for irrigation investigations, \$81,160 for drainage investigations, and \$10,000 for farmers' institutes and agricultural schools. The value of the additions to the equipment of the stations in 1910 is estimated as follows: Buildings, \$331,974.25; libraries, \$79,117.14; apparatus, \$47,505.12; farm implements,

\$62,950.11; live stock, \$35,124.59; miscellaneous, \$382,079.32; total, \$938,750.53.

The stations employ 1,403 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 56; assistant and vice directors, 23; special agents in charge, 4; chemists, 268; agriculturists, 43; agronomists, 160; horticulturists, 130; floriculturists, 6; pomologists, 6; viticulturists, 4; foresters, 19; plant breeders, 14; botanists, 76; plant physiologists, 5; plant pathologists, 47; mycologists, 3; bacteriologists, 48; animal husbandmen, 98; dairymen, 81; veterinarians, 51; animal pathologists, 7; poultrymen, 25; zoologists, 8; entomologists, 107; meteorologists, 11; biologists, 8; physicists, 11; geologist, 1; irrigation engineers, 16; agricultural engineers and farm mechanics, 12; extension workers and farmers' institute directors, 24; in charge of substations, 54; farm and garden foremen, 30; secretaries and treasurers, 31; and librarians, 19. There are also 40 persons classified under the head "Miscellaneous," including gardeners, laboratory and field assistants, herdsmen, editors, etc. Five hundred and fifty-two station officers do more or less teaching in the colleges with which the stations are connected. During the year the stations published 583 annual reports, bulletins, and circulars, which were supplied to over 952,000 addresses on the regular mailing lists. A larger number of stations than formerly supplemented their regular publications with more or less frequent issues of press bulletins and other special publications, and most of the stations report a large and constantly increasing correspondence with farmers on a wide variety of topics.

STATISTICS OF THE LAND-GRANT COLLEGES AND UNIVERSITIES.¹

Unless otherwise specified, the statistics reported in the tables are for the institutions as designated in the list given below.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study.*

[All of the institutions in this list, except those marked with an asterisk (*), maintain courses of instruction in agriculture.]

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Degree courses. ²	Preparatory and short courses.
Alabama	Alabama Polytechnic Institute.	Auburn.....	C. C. Thach, M. A., LL. D.	Agr., civil engin., archt., elect. engin., mech. engin., mining engin., phar., general, chem. and metal. (B. S.); phar. (2 yrs., Ph. G.; 3 yrs., Ph. C.); vet. med. and surgery (3 yrs., D. V. M.).	Agr., mech. arts (2 yrs.), agr. (1 yr.), summer school for farmers (10 days).
	Agricultural and Mechanical College for Negroes.	Normal.....	W. S. Buchanan, B. S. A.	Sci., agr., mech. (B. S.).....	Indus. and lit. studies (1 to 4 yrs.).
Arizona	University of Arizona	Tucson.....	K. C. Babcock, Ph. D.	Lit. (A. B.), sci., metal., mining engin., civil engin., mech. engin. (B. S.).	Agr. (2 yrs.), prep. (4 yrs.).
Arkansas	University of Arkansas.	Fayetteville.....	J. N. Tillman, LL. D.	Agr. (B. S., A.), mech. engin. (B. M. E.), elect. engin. (B. E., E.), civil engin. (B. C. E.), mining engin. (B. M. E.), chem. engin. (B. Ch. E.), chem. (B. S., C.), phys. (B. S. in Phys.), lit. and sci. (B. A. and B. S.), music (B. Mus.), normal (L. L.).	Agr., hort., dairying, elect. engin. (2 yrs.), mech. arts (2 or 3 yrs.), prep. 1 yr., agr. (3 weeks), art. (1 yr. and 4 yrs.).
California	* Branch Normal College. University of California.	Pine Bluff.....	Isaac Fisher ³	Clas. (B. A.), normal (L. L.).....	Prep. (2 yrs.), manual training, mech. arts (4 yrs.).
		Berkeley.....	B. I. Wheeler, Ph. D., LL. D.	Letters (A. B.), social sci. (B. L.), natural sci., commerce, general and tech. agr. (4 yrs. each), mech. engin., elect. engin., mining and metal., civil engin., chem., sugar technol. (B. S.) (4 and 5 yrs. each).	Agr., animal indus. and vet. sci., irrig. poultry husb., dairying, nutrition, ent., vit., hort. (2-8 weeks each), summer session (6 weeks), farmers' week.
Colorado	The State Agricultural College of Colorado.	Fort Collins.....	C. A. Lory, M. S., LL. D.	Agron., animal husb., ent., farm mech., forestry, hort., mech. engin., civil and irrig. engin., elect. engin., general sci., general sci. and home econ. (B. S.), vet. sci. (D. V. S., 3 yrs.).	Agr., domestic sci. (3 yrs. of 6 months each; optional fourth year of 9 months for college entrance), mech. arts (2 yrs.), book-keeping, farriery (1 yr. each), farmers', and dom. sci. week, libr. sci. and handicraft.

¹ Including also institutions receiving apportionments from the appropriations of 1890 and 1907.

² Four-year courses unless otherwise specified.

³ Principal.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study*—Continued.
[All of the institutions in this list, except those marked with an asterisk (*), maintain courses of instruction in agriculture.]

State or Territory.	Name of Institution.	Location.	President.	Degree courses. ¹	Collegiate courses of study (undergraduate).	Preparatory and short courses.
Connecticut.....	Connecticut Agricultural College.....	Storrs.....	C. L. Beach, B. Agr., B. S.	Agr. (B. S.).....	.....	Prep. (2 yrs.), agr. (including dairy and poultry husb. and hort.), mech. arts, home econ. (3 courses 3 yrs. each, diploma), summer school of nature study and agriculture (4 weeks), dairy and poultry husb., pomol. (winter, 6 weeks). Agr. (2 yrs.), farmer's week.
Delaware.....	Delaware College.....	Newark.....	G. A. Harter, M. A., Ph. D.	Clas., Lat. sci. (B. A.), agr., general sci., civil engin., mech. engin., elect. engin. (B. S.). Sci. (B. S.), agr. (B. Agr.), engin. (B. E.)....	.....	Normal (3 yrs.), industrial prep. (2 yrs.).
Florida.....	State College for Colored Students. University of Florida.	Dover..... Gainesville.....	W. C. Jason, A. M., D. D. A. A. Murphree, A. M., LL. D.	Lit. (B. A.), pedag. (B. A. in Ped.), gen. sci., agron., hort., animal husb., agr.-chem., agr.-pedag., mech. engin., elect. engin., civil engin. (B. S.), law (LL. B.).	.....	Agr., mech. arts, pedag. (2 yrs.), prep. (1 yr.), summer school for teachers (6 weeks), corresp. course in agr. for teachers and farmers, farmers' short course (12 weeks). English normal (2 yrs.), high school (3 yrs.), grammar school (3 yrs.), indus. training through all courses, corresp. course in agr. Agr., hort., dairying (1 yr.), agr. (winter, 12 weeks), cotton grading and agr. (Jan. and June, 5 weeks each), cotton school (winter, 10 days), farmers' week. Normal (3 yrs.), industrial, prep. (3 yrs.), dairying (1 year). Agr., dom. sci., miscel. (10 weeks), corresp. Prep. (4 yrs.), agr. (3 yrs.), dairying (com'l, 1 yr.), dairying and hort. (winter, 4-6 weeks), forest rangers (winter).
Georgia.....	Florida Agricultural and Mechanical College for Negroes. Georgia State College of Agriculture and Mechanic Arts.	Tallahassee..... Athens.....	N. B. Young, M. A..... A. M. Soule, B. S. A., D. Sc.	Sci. (B. S.)..... General sci., agr., civil engin., elect. engin., forest engin. (B. S.), phar. (2 yrs., Ph. C.).	.....	.....
Hawaii.....	Georgia State Industrial College.	Savannah.....	R. R. Wright, A. M., LL. D.	Collegiate (A. B.).....	.....	.....
Idaho.....	College of Agriculture. University of Idaho.....	Honolulu..... Moscow.....	J. W. Gilmore, M. S. A., J. A. MacLean, Ph. D., LL. D.	Sci., agr., home econ., engin. (B. S.)..... Clas. (B. A.), sci. (B. S.), agron., animal husb., dairying, hort., forestry, agr. ed. (B. S. Agr.), domestic econ. (B. S. D. E.), vet. sci., civil engin. (B. S. C. E.), mining engin. (B. S. Min. E.), elect. engin. (B. S. E. E.), mech. engin. (B. S. M. E.), chem. engin. (B. S. Chem.), music (B. M.), law (3 yrs., LL. B.).	.....	.....
Illinois.....	University of Illinois	Urbana.....	E. J. James, Ph. D., LL. D.	Lit. and arts, general sci. (B. A.), archi., archi. engin., archi. decoration, civil engin., elect. engin., mech. engin., railway engin., municipal and sanitary engin., mining engin., ceramics, ceramic engin., chem., chem. engin., sol., agr., household sci., land-	.....	Prep., including agr. and dom. sci., summer school, including secondary and el. agr. for rural teachers (6 weeks), agr. and domestic sci. (2 weeks).

Indiana.....	Purdue University...	Lafayette.....	W. E. Stone, Ph. D., LL. D.	<p>scape gard. (B. S.), music (B. M.), libr. sci. (B. L. S.), 5 yrs.; med. (M. D.), dentistry (3 yrs.), D. D. S., phar. (2 yrs., Ph. G.), law (3 yrs., LL. B.), phar. chem. (2 yrs., Ph. C.).</p> <p>Mech. engin. (B. S. M. E.), civil engin. (B. S. C. E.), elect. engin. (B. S. E. E.), chem. engin. (B. S. Ch. E.), agr. (B. S. Agr.), sci., household econ. (B. S.), phar. (B. S. Phar.), phar. (2 yrs., Ph. G.).</p> <p>Agron., dairying, animal husb., hort. and forestry, agr. engin., sci. and agr. (B. S.), vet. med. (D. V. M.), mech. engin. (B. M. E.), civil engin. (B. S. C. E.), elect. engin. (B. S. in E. E.), mining engin. (B. S. in Mn. E.), sci. (B. S.), ceramics (B. S. in Cer.), dom. sci. (B. S. in D. E.).</p>
Iowa.....	Iowa State College of Agriculture and Mechanic Arts.	Ames.....	A. B. Storms, A. M., D. D., LL. D.	<p>Agron., animal husb., dairy husb., hort. and dom. sci., mech. engin., general sci., elect. engin., civil engin., archit., printing (B. S.), vet. med. (D. V. M.).</p>
- Kansas.....	Kansas State Agri- cultural College.	Manhattan.....	H. J. Waters, B. S. A.	<p>Clas. (A. B.), mech. engin. (B. M. E.), civil engin. (B. C. E.), mining engin. (B. E. M.), agr. (B. S. Agr.), sci., dom. sci. (B. S.), education (B. S. Educ. and A. B. Educ.), law (3 yrs., LL. B.).</p>
Kentucky.....	State University.....	Lexington.....	J. K. Patterson, Ph. D., LL. D.	
	The Kentucky Nor- mal and Industrial Institute for Colored Persons.	Frankfort.....	E. E. Reed, acting...	
Louisiana.....	Louisiana State Uni- versity and Agri- cultural and Me- chanical College.	Baton Rouge.....	T. D. Boyd, A. M., LL. D.	<p>Agr., elect. engin., chem. engin., civil engin., mech. engin., general sci., premed. (B. S.), commerce, let. sci., lit., philos., psychol. and ed. (B. A.), sugar engin. (5 yrs., B. S.), law (2 yrs., LL. B.), law (3 yrs., B. C. L.).</p>
	Southern University and Agricultural Mechanical College.	New Orleans.....	H. A. Hill.....	

¹ Four-year courses unless otherwise specified.

Agr. and hort., animal husb., dairy husb., dom. sci. and agr. (winter, 8 weeks), butter making (10 days, winter), farmers' week.

Mining engin., clay working (2 yrs.), prep. (1 yr.), dairying (1 yr.), poultry husb. (1 yr.), dairying (16 weeks), corn and grain judging, stock judging, domestic econ., hort. and forestry, agr. engin., dairying, poultry husb. (winter, 2 weeks each), summer vacation school of road invest-igation.

Prep. (2 yrs.), agr. (2 yrs.), domestic sci. (2 terms, 12 weeks each), farmers' (2 winter terms, 10 weeks each), summer domestic sci. course for teachers (10 weeks), dairying (2 winter terms, 10 weeks each), dairy manl. (1 yr., winter, agr. for teachers (summer, 6 weeks), farmers' week, corresp. courses in agr.

Agr. (2 yrs.), prep. (3 yrs.), rural and high-way engin. (2 yrs.), mining engin. (2 yrs.), pract. mining (8-10 weeks), agr. (winter, 10 weeks).

Normal (3 or 4 yrs.), agr., carpentry, cook-ing, music, dressmaking, printing, black-smithing, wheelwrighting (3 yrs.), busi-ness (2 yrs.), manual training courses in mech. draw., agr., printing, carpentry, sew. and cooking.

Agr. (3 yrs.); agr. (2 weeks, winter), summer school including agr. for teachers and others.

Sci., agr., high school, printing, girls' indus. (4 yrs.), clas., normal, manual training, grammar, mech. drawing, thinsmithing (3 yrs.), bookkeeping, typewriting (2 yrs.), music (3 yrs.).

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study—Continued.*

[All of the institutions in this list, except those marked with an asterisk (*), maintain courses of instruction in agriculture.]

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Degree courses. ¹	Preparatory and short courses.
Maine.....	University of Maine..	Orono.....	G. E. Fellows, Ph. D., L. H. D., LL. D.	Clas. sci. (B. A.), agron., animal husb., hort., dom. sci., chem., civil engin., mech. engin., elect. engin., chem. engin., forestry phar., el. agr. for teachers (B. S.), law (3 yrs., LL. B.), phar. (2 yrs., Ph. C.).	Secondary agr. (2 yrs.); agr. for teachers (1 yr.), dom. sci. for teachers (2 yrs.), agr. and dairying (4 weeks), poultry manage- ment, hort. and dom. sci. (3 weeks, spring), summer school for teachers (5 weeks), farmers' week, reading and corre- spondence courses in agr. and dom. sci. Agr., hort. (2 yrs.), prep. (1 yr.), agr. and hort. (winter, 10 weeks).
Maryland.....	Maryland Agricultur- al College.	College Park.....	R. W. Silvester, M. S., LL. D.	Agron., animal husb., hort., chem., gen. sci., biol., mechan. engin., civil engin., elect. engin. (B. S.).	College prep. and normal (4 yrs.), grammar (2 yrs.), indus. courses in agr., dairying, blacksm., wheelwrt., carpentry, printing, dom. sci. and art.
Massachusetts.....	Princess Anne Acad- emy for Colored Persons.	Princess Anne.....	Frank Trigg, A. M. ².....	.....	Agr., hort., floriculture, dairying (winter, 10 weeks), poultry mgt. (2 weeks), bee- keeping (May), summer school of agr., school gard., home econ., etc., for teachers et al. (2, 4, and 6 weeks), farmers' week, corresp. course.
	Massachusetts Agri- cultural College.	Amherst.....	K. L. Butterfield, A. M., LL. D.	Agr. (B. S.).....	
	*Massachusetts Insti- tute of Technology.	Boston.....	R. C. Macdairin, M. A., LL. D., D. Sc.	Civil engin., mech. engin., mining engin. and metal., archt., chem., elect. engin., biol., phys., electro-chem., chem. engin., sani- tary engin., geol. and geodesy, naval archt., general sci. (B. S.).	Prep. (1 yr.), agr. for teachers (1 yr.), cheese making (4 weeks), general agr., poultry husb. (2 winter terms of 8 weeks each), creamery (2 winter terms of 6 weeks each), summer school of agr. and dom. sci. for teachers (4 weeks), hort. (4 weeks, winter), forestry (2 summer terms of 6 weeks each), college ext. reading course.
Michigan.....	Michigan State Agri- cultural College.	East Lansing.....	J. L. Snyder, Ph. D., LL. D.	Agr., engin., hort., forestry, home econ. (B. S., each 4 and 5 yrs.), vet. sci. (D. V. M.).	Sec. agr. (3 yrs.), home econ. normal (2 yrs., certif.), agr. indus. course for teachers (2 yrs.), agr. (4 weeks), forestry (summer, 6 weeks), dairying (winter, 4 weeks), trac- tion engin. (4 weeks), el. agr., nature study and dom. sci. and art for teachers (summer, 3 weeks).
Minnesota.....	The University of Minnesota.	Minneapolis.....	Cyrus Northrop, LL. D.	Sol., lit., and arts (B. A.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), mining metal. (E. M., Met. E.), chem. (H. S., in Chem.), agr. (B. S., Agr.), forestry (B. S., For.), home econ. (B. Sc.), education (B. A. in Ed.).	

Mississippi.....	Mississippi Agricultural and Mechanical College.	Agricultural College.	J. C. Hardy, A. M., LL. D.	Aggr., mech. engin., elect. engin., civil and mining engin., textile indus., indus. pedagogy (B. S.).	Aggr., mech. arts, textile (2 yrs.), prep. (1 yr.), pract. working boys' course (1 yr.), agr. (10 weeks), summer normal school for teachers (4 weeks), agr. (summer, 2-4 weeks).
Alcorn.....	Alcorn Agricultural and Mechanical College.	Alcorn.....	L. J. Rowan, B. S., Ph. D.	Sci., agr. (B. S.).	Carp., blacksm. (4 yrs.), shoemak., nurse training, paint., dom. sci., millinery, etc. (3 yrs. & agr. (2 yrs.)), prep. (2 yrs.), primary (3 yrs.).
Missouri.....	University of Missouri.	Columbia.....	A. R. Hill, Ph. D., LL. D.	Gen. sci. (B. A.), agr., home econ. (B. S.), civil engin. (B. S., C. E.), mech. engin., min. engin. (B. S., M. E.), elect. engin. (B. S., E. E.), chem. engin., chem. and metal., journalism, educ. (B. S.), law (3 yrs., LL. B.).	Aggr. (winter, 2 yrs. of 14 weeks each), mining and assaying, electricity, surveying (2 yrs. each), summer school for teachers (9 weeks), poultry husb. (winter, 2 weeks), farmers' week.
Lincoln.....	Lincoln Institute.....	Jefferson City.....	B. F. Allen, A. M., LL. D.	Collegiate (B. A.).	Normal, subnormal (4 yrs. each), indus. (3 yrs.), agr., dom. sci. and art, mech. draw., carpentry, blacksmithing, mach. and engin. (2 yrs.), summer school (9 weeks), music (8 grades).
Montana.....	Montana State College of Agriculture and Mechanic Arts.	Bozeman.....	J. M. Hamilton, M. S.	Mech. engin. (B. M. E.), elect. engin. (B. E. E.), civil engin. (B. C. E.), agron., animal husb. and dairying, hort., home sci., chem., biol., math-physics, history-lit., phar. (B. S.), phar. (2 yrs., Ph. C.).	Prep., music, art (4 yrs.), sec. agr. (3 yrs.), home sci. (1 yr.), creamery (4 weeks), poultry, dairying, stock judging, dom. sci. (1 week each).
Nebraska.....	University of Nebraska.	Lincoln.....	Samuel Avery, Ph. D.	Clas. lit. (B. A.), general sci., general agr., home econ., agr. engin., civil engin., elect. engin., municipal engin., mech. engin., forestry, phar. (B. S.), teachers' course (B. A. and B. S.), med. (M. D.), law (3 yrs., LL. B.), phar. (3 yrs., Ph. C., 2 yrs., Ph. G.).	Vocational agr., home econ. (4 yrs. each), high and normal and grade and rural school teachers' courses in agr., home econ., and manual training (1 yr. each), home econ. for teachers (2 yrs.), agr. (winter, 7 weeks), teachers' summer school, including agr. and home econ. (3 weeks).
Nevada.....	University of Nevada.	Reno.....	J. E. Stubbs, M. A., D. D., LL. D.	Liberal arts (B. A.), mining engin., agr., domestic sci., mech. engin., civil engin., general sci. (B. S.).	Aggr. (2 yrs.), dairying (winter, 10 weeks), farmers' week.
New Hampshire.....	The New Hampshire College of Agriculture and Mechanic Arts.	Durham.....	W. D. Gibbs, D. Sc...	Aggr., mech. engin., elect. engin., chem. engin., arts and sci. (B. S.).	
New Jersey.....	Rutgers Scientific School, The New Jersey State College for the Benefit of Agriculture and Mechanic Arts.	New Brunswick.....	W. H. S. Demarest, A. M., D. D., LL. D.	Clas. (A. B.), Lat. sci. (Litt. B.), general sci., agr., civil engin., mech. engin., elect. engin., chem., biol., clay working and ceramics (B. S.).	Clay working and ceramics (2 yrs.), general agr., dairy farming, poultry husb., fruit growing, and market gardening (winter, 12 weeks each), farmers' week.
New Mexico.....	New Mexico College of Agriculture and Mechanic Arts.	Agricultural College.	W. E. Garrison, Ph. D.	Aggr., mech. engin., civil engin., elect. engin., household econ., commerce, general sci. (B. S.).	Sec. indus. agr., mech. indus., dom. sci., indus. business, prep. (4 yrs. each), Engl. and Engl-Spanish sten. (2 yrs. each).

: Principal.

1 Four-year courses unless otherwise specified.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study*—Continued.

[All of the institutions in this list, except those marked with an asterisk (*), maintain courses of instruction in agriculture.]

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Degree courses. ¹	Preparatory and short courses.
New York.....	Cornell University....	Ithaca.....	J. G. Schurman, D. Sc., LL. D.	Arts (A. B.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), archi. (B. Arch.), agr. (B. S. A.), vet. med. (3 yrs., D. V. M.), law (3 yrs., LL. B.).	Archl. (2 yrs.), special lect. courses in general agr. and nature study (1 or 2 yrs.), agr., dairying, poultry husb., hort., home econ. (winter, 11 weeks), reading courses for farmers and farmers' wives, summer school for teachers, nature study correspondence course for teachers, farmers' week.
North Carolina.....	The North Carolina College of Agriculture and Mechanic Arts.	West Raleigh.....	D. H. Hill, A. M., Litt. D.	Agr. (B. S.), mech. engin., civil engin., elect. engin., textile sci. and art (B. E.), chem., dyeing (B. S.).	Mech. arts, textile art (2 yrs.), normal courses in agr. and nature study (1 and 2 yrs.), agr. (1 yr.), agr. and dairying (7 weeks, winter), May school for agr. teachers (1 month), corn culture (1 week, January).
North Dakota.....	The Agricultural and Mechanical College for the Colored Race. North Dakota Agricultural College.	Greensboro..... Agricultural College.	J. B. Dudley, A. M., LL. D. J. H. Worst, LL. D....	Agr. (B. Agr.), mech. (B. S.)..... Agr., gen. sci., home econ., biol., mech. engin., civil engin., pharm. chem., chem. engin., education, vet. sci. (B. S.).	Prep. (1 yr.), agr. (2 yrs.), summer school (3 weeks). Farm husb., power mach. (3 yrs. each), phar., home econ. (2 yrs.), high-school agr., commerce, dom. sci., mech. arts and manual training, general sci. (3 yrs.), nature study, el. agr., dom. sci. and manual training for rural teachers (3 yrs.), agr., steam engin., dom. econ. (winter, 10 weeks each), traction engin. (summer, 4 weeks), summer school for teachers including agr., nature study, and home econ. (4 weeks), music.
Ohio.....	Ohio State University.	Columbus.....	W. O. Thompson; A. M., D. D., LL. D.	Agr. (B. S. Agr.), ed., hort., forestry, dom. sci., chem. engin., indus. arts, manual training, phar. (B. S.), arts, philos. and sci. (B. A.), archi. (C. E. in Archi.), civil engin. (C. E.), ceramic engin. (Cer. E.), min. engin. (E. M.), elect. engin. (M. E. in E. E.), mech. engin. (M. E.), vet. med. (3 yrs., D. V. M.), law (3 yrs., LL. B.).	Agr., hort., ed., clay working, indus. arts, mining, phar. (2 yrs.), agr. (10 weeks), summer session (8 weeks), winter dairy school.

Oklahoma.....	Stillwater.....	J. H. Connell, M. S.....	Agr., mech. engin., archi. and civil engin., elect. engin., sci. and lit., dom. sci. and art, normal (B. S.).	Sec. agr. and dom. sci. (2 yrs.), business, agr. (1 yr.), agr. and dairy (winter, 10 weeks), dairying (winter, 4 weeks), cotton grading (3 weeks), ice cream making (2 weeks), milk and cream testing (1 week), summer normal for teachers of agr. (6 weeks), reading course in agr. for teachers (2 yrs.), farmers' week. Normal, el. with required agr. (4 yrs. each), prep. (3 yrs.), agr. (3 yrs.), agr. (1 yr.), trade courses in carpentry, mach., blacksm., steam engin. (3 yrs.).
Oregon.....	Langston.....	I. E. Page, A. M.....	Clas. (B. A.), sci. (B. S.), normal (B. S. D.), agr. (B. S. Agr.), elect. engin., mech. engin., archi. engin. (B. M. E.).	Normal, el. with required agr. (4 yrs. each), prep. (3 yrs.), agr. (3 yrs.), agr. (1 yr.), trade courses in carpentry, mach., blacksm., steam engin. (3 yrs.).
	Corvallis.....	W. J. Kerr, D. Sc.....	Agron., hort., animal husb., dairy husb., ent., bact., vet. sci., poultry husb., mech. engin., elect. engin., civil engin., mining engin., dom. sci. and art, forestry, phar., commerce (B. S.).	Sec. agr., dom. sci. and art, commerce, forestry, mech. arts (2 yrs.), phar. (2 yrs.), agron., animal husb., dairying, hort., forest rangers, dom. sci. and art, mech. arts (winter, 6 weeks each), summer school for teachers including agr. and home econ. (6 weeks), farmers' week, music art.
Pennsylvania.....	State College.....	E. E. Sparks, Ph. D., LL. D.	Classical, mod. lang. and lit., history and pol. sci., philos. and ed., prep. to law, agr. chem., agron., animal husb., dairying, hort., landscape gard., forestry, home econ., biol., chem., civil engin., elect. engin., electrochem. engin., indus. chem., flour mill engin., indus. engin., math., archi. engin., mech. engin., mining engin., metal engin., plant path., phys., prep. to med., sanitary engin. (B. S.).	Agr., mech. arts for teachers (2 yrs.), agr., hort., dairy husb., dairy mant., poultry husb., home econ. (12 weeks), summer session for teachers (6 weeks), 33 corresp. courses in agr. and dom. sci., farmers' week.
Porto Rico.....	University of Porto Rico.....	E. G. Dexter, A. M., Ph. D.	.....	Normal nature study, el. agr., sewing, bot., zool. (18 weeks each), dom. sci., school gardening (1 yr. each).
Rhode Island.....	Rhode Island College.....	Howard Edwards, M. A., LL. D.	Agr., mech. engin., civil engin., chem. engin., elect. engin., teachers' course in applied sci., home econ. (B. S.).	Agr. (2 yrs.), mech. arts (2 yrs.), dom. sci. (2 yrs.), poultry school (winter, 6 weeks), summer school for teachers et al., in el. agr., nature study, school gard., and dom. sci., farmers' week.
South Carolina.....	The Clemson Agricultural College of South Carolina.....	W. M. Riggs, E. M. E.	Agr., agr. and chem., agr. and animal husb., mech. and elect. engin., civil engin., chem., and geol., textile indus. (B. S.).	Textile indus. (2 yrs.), prep. (1 yr.), cotton grading (6 weeks), farmers' course (winter, 6 weeks).
	The Colored Normal, Industrial, Agricultural and Mechanical College of South Carolina.....	T. E. Miller, LL. D.....	Collegiate (B. A.), mech. (B. S.), agr. (B. Agr.).	Prep. (3 yrs.), normal (4 yrs., L. 1.), model school, indus., music, art.

¹ Four-year courses unless otherwise specified.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study—Continued.*

[All of the institutions in this list, except those marked with an asterisk (*), maintain courses of instruction in agriculture.]

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Degree courses. ¹	Preparatory and short courses.
South Dakota.....	South Dakota State College of Agriculture and Mechanic Arts.	Brookings.....	R. L. Slagle, A. M., Ph. D.	Agr., home econ., general sci., mech. engin., elect. engin., civil engin., phar. (B. S.), phar. (2 yrs., Ph. G.).	Prep., coml. sci., soc. agr. and home econ. (3 yrs.), music (2 courses, 3 yrs. each), steam engin. (5 months), creamery (3 months), agr. and home econ. (12 weeks), agr., dairying (winter, 2 weeks), summer session for teachers, including agr., home econ., etc. (3 weeks), corresp. courses in agr., nature study, and home econ., art.
Tennessee.....	University of Tennessee.	Knoxville.....	Brown Ayres, Ph. D., LL. D., D. C. L.	Lit. (B. A.), agr., home econ., sci., civil engin., mech. engin., elect. engin., mining engin., metal engin., chem. engin. (B. S.), med. (M. D.), education (B. A. and B. S. in Ed.), dental surgery (3 yrs., D. D. S.), law (2 yrs., LL. B.).	El. agr. for negroes (4 yrs.), agr., prep. med. (2 yrs. each), agron., hort., animal husb., dairy husb., poultry husb., beekeeping, home econ. (10 weeks, in succession 2 weeks each), summer school of agr. for teachers (6 weeks).
Texas.....	Agricultural and Mechanical College of Texas.	College Station....	R. T. Milner.....	Agr., elect. engin., mech. engin., civil engin., archit., archit. engin., chem. engin. (B. S.).	Agr. (2 yrs.), textile engin. (2 yrs.), agr. for teachers (2 yrs.), summer school (6 weeks), summer normal (6 weeks), practical farmers' course (6 weeks), corresp. course in agr.
Utah.....	Prairie View State Normal and Industrial College. Agricultural College of Utah.	Prairie View..... Logan.....	E. L. Blackshear ² J. A. Widtsoe, Ph. D..	..... Agron., hort., animal husb. and dairying, irrig. and drainage, home econ., econ. ent., agr. chem., commerce, general sci. (B. S.).	Normal and indus., including agr., mech. arts and dom. sci. (4 yrs.), mech. arts (3 yrs.), agr. and hort. (2 yrs.), dairying (2 yrs.), summer school. Manual training in mech. arts (4 yrs.), manual training in home econ. (3 yrs.), sec. commerce (3 yrs.), prep. (3 yrs.), agr. (2 yrs.), forest rangers (3 months, winter), commerce (2 yrs., winter), mech. arts (2 yrs., winter), agr., domestic sci. and arts (8 weeks), forestry (12 weeks), summer school (6 weeks), farmers' round-up and housekeepers' conf. (2 weeks) music.
Vermont.....	University of Vermont and State Agricultural College.	Burlington.....	M. H. Buckham, D. D., LL. D.	Clas. (B. A.), lit. sci. (Ph. B.), civil and sanitary engin., elect. engin., mech. engin., chem., agr., commerce and econ., education, home econ. (B. S.), med. (M. D.).	Agr. (2 yrs.), agr. (winter, 5 weeks), farm dairying (4 weeks), summer school for teachers including agr. and dom. sci. (6 weeks), creamery mg't, home econ. (2 weeks each), farmers' week.

Virginia.....	The Virginia Agricultural and Mechanical College and Polytechnic Institute. The Hampton Normal and Agricultural Institute.	Blacksburg..... Hampton.....	P. B. Barringer, M. D., LL. D. H. B. Frizzell, ² D. D., LL. D.	Aggr., hort., applied chem., civil engin., mech. engin., elect. engin., mining engin., metal. and metallurgy, applied geol., prep. vet. med. (B. S.).	Aggr. apprentice course (1 yr.), farmers' winter course (1 month).
Washington.....	State College of Washington.	Pullman.....	E. A. Bryan, A. M., LL. D.	Math., civil engin., phys., hydro-elect. engin., domestic econ., phar., chem., bot., zool., econ. biol., agron., animal husb., and dairying, hort., forestry, vet. sci., econ. sci. and hist., elect. engin., mech. engin., mining engin. (B. S., B. A.), geol., Engl. lang. and lit., modern lang., Latin, education, archi. (B. A.), vet. sci. (3 yrs., D. V. S.), phar. (2 yrs., Ph. G.), music (3 yrs., B. Mus.).	Academic (4 yrs.), trade (3 yrs.), pract. agr. (3 yrs.). Graduate: Agr. (1 yr.), dom. sci. and art (2 yrs.), matrons' course (2 yrs.), normal (2 yrs.), business (2 yrs.), library methods (2 yrs.), summer session for teachers in agr., dom. sci., etc. (4 weeks). Gold and metal mining (2 yrs. each), el. sci. (3 yrs.), art (2 yrs.), artisans (1 yr.), bookkeeping, sten. (1 yr. each), agr. (20 weeks) mining (12 weeks), dairying (8 weeks), summer science school for teachers (6 weeks).
West Virginia.....	West Virginia University.	Morgantown.....	D. B. Purinton, Ph. D., LL. D.	General culture (B. A., B. S.), mech. and elect. engin. (B. S. M. E.), civil engin. (B. S. C. E.), mining engin. (B. S. E. M.), agr. (B. S. Agr.), commerce (B. S. Com.), law (3 yrs. LL. B.), vet. sci. (3 yrs., D. V. S.).	Sec. agr. (3 yrs., diploma), dom. sci. for teachers (2 yrs.), commerce (2 yrs.), agr. (1 yr., cert.), prep. (4 yrs.), agr., hort., animal husb., dairying, poultry culture (12 weeks), el. agr. and nature study for teachers (summer, 6 weeks), agr. (winter, 4 weeks), music (3 and 4 yrs., cert.), art (4 yrs., diploma). Normal, agr., acad., mech., printing (4 yrs.), sewing, dressmaking, com ¹ , cooking, millinery.
West Virginia.....	The West Virginia Colored Institute.	Institute.....	Byrd Prillerman, A. M.		
Wisconsin.....	University of Wisconsin.	Madison.....	C. R. Van Hise, Ph. D., LL. D.	Sci., commerce, journalism (B. A.), normal (B. Ph.), agr. (B. S. Agr.), sci. agr. for teachers (B. S. and B. A.), civil engin., mining engin., mech. engin., elect. engin., general engin., applied electrochem., chem., chem. engin., phar., home econ. (B. S.), music (Grad. in Mus.) law (3 yrs. prof., LL. B.), phar. (2 yr., Ph. G.).	Aggr. (2 yrs.), agr. (2 winter courses, 14 weeks each), dairy school (winter, 12 weeks), creamery (summer, 10 weeks), farmers' course (10 days, winter), summer school, including agr. and home econ. (6 weeks), spec. cheese and creamery, housekeepers' boys' corn and seed grain (1 week), housekeepers' conf. corresp.
Wyoming.....	University of Wyoming.	Laramie.....	C. O. Merica, A. M., LL. D.	Liberal arts (B. A.), agr., home econ., mech. engin., elect. engin., civil engin., mining engin., irrig. engin. (B. S.), commerce (B. S. in Com.), normal (2 yrs., B. Ed.).	Prep., commerce (4 yrs.), animal husb., agr. (8 weeks, winter), summer school for teachers (6 weeks), music, corresp. courses.

¹ Four-year courses unless otherwise specified.² Principal.

TABLE 2.—General statistics of land-

	State or Territory.	Date of establishment of institution.	Date of establishment of agricultural course.	Faculty.				
				College of agriculture and mechanic arts.				
				Interior instruction.				
				Preparatory classes. ¹	Collegiate and special classes.			Total. ²
					Agriculture.	Mechanic arts.	All others.	
1	Alabama.....	1872	1872	4	10	15	40	65
2	Arizona.....	1891	1891	16	1	4	21	32
3	Arkansas.....	1872	1872	9	12			21
4	California.....	1868	1868		34	29		63
5	Colorado.....	1877	1878	27	18	10	22	50
6	Connecticut.....	1881	1881	7	8	1	15	24
7	Delaware.....	1870	1870		2	6	12	20
8	Florida.....	1884	1884	2	3	3	12	20
9	Georgia.....	1872	1872		13	3	29	45
10	Hawaii.....	1907	1907		3	2	8	13
11	Idaho.....	1892	1892	8	12	6	13	34
12	Illinois.....	1867	1868		48	98		146
13	Indiana.....	1874	1874		18	62	76	156
14	Iowa.....	1869	1869		16	33	67	116
15	Kansas.....	1863	1874		38	28	64	130
16	Kentucky.....	1865	1880	6	5	13		24
17	Louisiana.....	1877	1887	14	4	4	25	38
18	Maine.....	1865	1868	10	11			11
19	Maryland.....	1859	1859	2	14	5	9	28
20	Massachusetts (Amherst).....	1867	1867		41			41
21	Massachusetts (Boston).....	1865				9		9
22	Michigan.....	1855	1855		18	24	62	104
23	Minnesota.....	1869	1869	72	(⁴)	29		101
24	Mississippi.....	1880	1880	6	12	14	21	53
25	Missouri (Columbia).....	1870	1870		30	23		53
26	Montana.....	1893	1893	21	6	9	24	45
27	Nebraska.....	1869	1869	33	41	15	17	72
28	Nevada.....	1873	1888	17	6	3	21	31
29	New Hampshire.....	1866	1866	17	10	8	17	35
30	New Jersey.....	1864	1865	14	4	11	28	57
31	New Mexico.....	1889	1890	3	6	5	25	39
32	New York.....	1865	1865		87	78	7	172
33	North Carolina.....	1889	1889		14	19	12	45
34	North Dakota.....	1890	1890	49	9	10	43	62
35	Ohio.....	1870	1873		25	52	74	151
36	Oklahoma.....	1891	1892	3	16	5	38	62
37	Oregon.....	1868	1888	(⁵)	14	16	59	89
38	Pennsylvania.....	1855	1859		48	50	60	158
39	Porto Rico.....	1903	1904	8	7			15
40	Rhode Island.....	1888	1890	20	5	8	14	27
41	South Carolina.....	1889	1893	2	10	14	22	48
42	South Dakota.....	1881	1884	23	15	5	31	56
43	Tennessee.....	1794	1869	8	12	14	21	49
44	Texas.....	1871	1871		11	14	27	52
45	Utah.....	1888	1889	13	6	1	37	57
46	Vermont.....	1865	1885		9	17		26
47	Virginia.....	1872	1872		10	14	40	64
48	Washington.....	1892	1892	22	7	10	77	82
49	West Virginia.....	1867	1867	12	4	10		26
50	Wisconsin.....	1848	1866		68	67		130
51	Wyoming.....	1887	1891		6	4		10
Total.....				448	822	880	1,190	3,057

¹ Including schools of agriculture of high-school grade under the control of the institution.² Total, counting none twice.³ Including substations.

grant colleges for white students, 1910.

Faculty—Continued.			Library.		Number of acres allotted to State under act of 1862.	Number of acres of land grant still unsold.	Number of acres in farm and grounds.	Rate of interest on land-grant fund of 1862.		
College of agriculture and mechanic arts.		Other colleges or departments.	Total. ²	Number of volumes.						Number of pamphlets.
Agricultural extension department workers.	Experiment station officers. ³									
1	19	-----	65	23,974	3,000	240,000	-----	325	8	
-----	13	-----	42	15,000	14,000	-----	-----	545	2	
2	20	39	82	15,000	5,000	150,000	-----	160	8	
1	55	292	412	248,000	61,000	150,000	1,402	1,599	6	
1	28	-----	67	40,000	38,000	90,000	40,000	1,818	6	
1	12	-----	30	11,580	1,000	180,000	-----	675	5	
3	10	2	27	17,850	9,200	90,000	-----	227	6	
2	14	2	36	5,500	1,000	90,000	-----	520	6	
5	8	-----	58	36,000	-----	270,000	-----	987	7	
-----	-----	-----	13	6,000	8,000	-----	-----	90	10	
-----	19	17	59	22,506	-----	90,000	72,605	240	11	
4	63	562	673	157,836	20,865	480,000	-----	715	5	
7	50	-----	192	24,300	-----	390,000	-----	272	5	
14	37	-----	157	31,000	35,000	204,000	-----	1,175	6	
8	55	-----	150	36,434	800	82,313	-----	752	5,5½,6,7	
-----	28	53	86	19,695	11,500	330,000	-----	299	6	
2	23	20	59	29,000	-----	210,000	-----	724	4,5	
1	21	66	90	41,383	11,000	210,000	-----	473	5	
1	19	-----	38	10,000	4,100	210,000	-----	186	5,6	
2	31	-----	62	32,600	-----	360,000	-----	418	5	
-----	-----	201	210	86,554	1,090	-----	-----	18	21	
5	24	-----	120	31,824	6,708	235,673	50,722	684	7	
10	38	193	294	145,000	-----	94,000	-----	1,557	3,4,5	
2	20	-----	62	11,525	9,113	207,920	-----	2,000	6	
1	42	125	183	100,689	20,000	277,016	47,607	678	5	
-----	16	-----	51	9,800	6,000	90,000	122,350	380	26	
-----	35	189	276	90,500	10,000	90,000	3,203	330	4½,6	
-----	14	9	40	17,823	11,000	90,000	2,000	95	4	
-----	16	-----	35	26,141	8,500	150,000	-----	345	6	
-----	12	-----	63	61,560	5,000	210,000	-----	145	5	
-----	16	-----	39	13,147	5,000	-----	-----	489	31	
-----	43	505	625	383,696	57,000	989,920	-----	1,094	5	
1	18	-----	46	7,221	2,600	270,000	-----	685	6	
2	38	-----	74	22,360	1,000	130,000	36,398	640	34	
3	-----	63	217	95,837	4,000	630,000	-----	439	6	
1	13	-----	63	14,120	30,000	250,000	250,000	1,000	36	
-----	34	-----	103	8,973	11,000	90,000	4,200	237	6	
2	43	-----	158	40,000	30,000	780,000	-----	400	6	
-----	-----	14	29	3,400	1,300	-----	-----	270	39	
3	21	-----	43	17,971	3,000	120,000	-----	178	3	
4	14	-----	58	15,030	9,000	180,000	-----	1,296	6	
2	24	-----	56	11,760	10,000	160,000	155,682	560	42	
-----	22	94	161	29,658	20,708	300,000	-----	272	6	
-----	27	-----	75	21,250	-----	180,000	-----	2,416	6,7	
1	22	-----	58	18,220	20,038	200,000	22,992	124	45	
-----	16	63	105	80,511	34,145	150,000	-----	175	6	
-----	16	-----	71	12,000	31,000	300,000	-----	408	6	
4	32	-----	103	23,131	5,000	90,000	80,062	466	48	
1	15	49	91	40,964	3,400	150,000	-----	130	6	
1	70	329	459	151,580	45,600	240,000	244	770	4	
-----	13	33	43	28,000	12,000	90,000	90,000	514	51	
98	1,239	2,920	6,409	2,443,903	636,667	10,570,842	979,467	30,506	-----	

⁴ Most of the collegiate agricultural work is done in the College of Science, Letters, and Arts.⁵ Included in collegiate classes.

TABLE 3.—*Graduates, and students by classes, at land-grant colleges for white students, in 1910.*

State or Territory.	Graduates.				Total number since organization.	Students by classes.										Total. ²
	In 1909-10.					College of agriculture and mechanic arts.					Exterior courses.					
	Agricultural courses.	Mechanico-arts courses.	All other courses.	Total.		Interior courses.				Short courses.		Total. ²	Correspondence.	Extension schools of five days or longer. ³	Other departments. ⁴	
						Preparatory. ¹	Collegiate.	Post-graduate.	One to two year, and winter.		Summer.					
Alabama.....	12	5	85	102	1,259	74	668	18				700		1,000		1,700
Arizona.....			5	5	77	103	106	13				200				200
Arkansas.....		2	76	78	734	218	724	12	35			989				989
California.....	22	113	355	490	6,151	51	1,025	50				1,126	115		4,100	5,341
Colorado.....	25	14	3	42	404	217	331		330	41		878				878
Connecticut.....	1			1	314	76	121		16			253				253
Delaware.....		25		27	473		158	5	40			203				203
Florida.....		6	3	9	135	27	90	4	4			135				135
Georgia.....	6	19		25	518		247	2	84	370		703		1,260	52	1,963
Hawaii.....							64		51			115		426		541
Idaho.....	7	10	17	34	289	165	163		47			375			161	556
Illinois.....	49	191	412	652	6,369		1,972	79		(6)		2,051			3,045	5,096
Indiana.....	24	221	64	309	3,635		1,648	102	117			1,867		4,541		6,408
Iowa.....	54	101	52	207	2,428	219	1,530	20	627			2,350		11,613		13,963
Kansas.....	38	32	71	141	1,708	542	1,455	23	350	41		2,305		372		2,677
Kentucky.....	3	16	71	90	841	154	160	15	45			374			347	721
Louisiana.....	6	12	56	74	615	105	112	6	50	71		344			639	974
Maine.....	11	61	47	119	1,445	19	486	12	55			572	124	56	322	1,031
Maryland.....	18	3		21	322	65	132	8	42			267				267
Massachusetts (Amherst).....	42			42	864		332	18	64	176		590				696
Massachusetts (Boston).....			252	252	4,346		298			47		345			1,134	1,479
Michigan.....	35	40	17	92	1,545	188	1,019	8	259	28		1,494				1,494
Minnesota.....	25	51	470	546	7,912	833	683	9	492	266		2,283		550	3,086	5,919
Mississippi.....	19	24	13	56	637	269	659	16		418		1,362				1,362
Missouri.....	31	67	269	367	3,757		335	17	158	19		529			2,393	2,903
Montana.....		10	9	19	114	145	192	6	745			388		47		435
Nebraska.....	11	63	246	320	3,767	402	600	6	123	36		1,137			2,966	3,992
Nevada.....	1	15	13	29	452	114	126	3				243			91	334
New Hampshire.....	6	15	13	34	413	48	192					452				452

	2	20	42	744	187	268	3	80	538	68	606
New Jersey.....	.....	.....	9	106	188	81	4	2	.....	.....	273
New Mexico.....	.....	6	707	11,404	.....	1,725	.....	367	24,799	3,102	29,983
New York.....	47	219	441	525	.....	358	.....	175	2,092	.....	1,170
North Carolina.....	9	.....	57	105	563	150	10	474	1,252	600	1,252
North Dakota.....	3	.....	17	3,344	.....	1,361	.....	159	1,530	2,020	3,275
Ohio.....	27	103	339	262	198	449	10	8,847	1,679	.....	1,679
Oklahoma.....	2	25	47	966	246	728	.....	9,676	1,591	.....	2,704
Oregon.....	23	50	120	966	246	728	21	22	1,417	.....	3,107
Pennsylvania.....	21	120	163	1,472	241	1,333	2	92	1,392	683	1,075
Porto Rico.....	.....	.....	.....	.....	241	51	.....	.....	.....	.....	1,075
Rhode Island.....	3	0	15	165	29	145	6	81	261	19	280
South Carolina.....	33	22	77	682	67	583	.....	3	653	.....	653
South Dakota.....	3	11	26	425	288	173	10	104	176	.....	731
Tennessee.....	5	18	108	.....	132	275	5	78	88	413	3,598
Texas.....	13	.....	70	799	36	782	.....	118	900	.....	900
Utah.....	14	57	.....	210	374	306	2	247	115	.....	1,044
Vermont.....	9	29	36	4,134	255	.....	.....	29	1,044	214	498
Virginia.....	5	26	64	864	66	430	13	37	346	.....	546
Washington.....	3	35	47	497	119	117	10	171	4	1,077	1,369
West Virginia.....	3	10	73	1,282	10 133	28	1	112	302	126	1,422
Wisconsin.....	2	12	46	7,645	1,127	.....	57	2,188	3,372	3,202	8,048
Wyoming.....	29	114	519	193	48	.....	.....	59	1,474	178	228
Wyoming.....	2	7	23	.....	.....	.....	3	.....	50	.....	.....
Total.....	707	2,045	6,807	87,328	6,921	26,411	615	9,100	45,140	21,004	128,140

¹ Including schools of agriculture of high-school grade under the control of the institution.

² Total, counting none twice.

³ Not including farmers' institutes.

⁴ Including summer schools.

⁵ Including 113 music students.

⁶ Not classified.

⁷ Including 31 music students.

⁸ Including 93 in commercial courses.

⁹ Including 70 music students.

¹⁰ Preparatory to all colleges of the university.

Ohio.....	167	16	28	137	833	207	6	24	237	203	.....	.....	.....	22	1,075
Oklahoma.....	147	.....	.....	63	138	681	.....	.....	681	.....	.....	222	.....	99	412
Oregon.....	133	.....	14	114	284	11,405	72	21	507	.....	.....	.....	.....	.....	670
Pennsylvania.....	216	.....	121	20	739	174	.....	8	174	.....	.....	.....	.....	56	657
Porto Rico.....	51	.....	.....	.....	199	199	.....	.....	207	.....	.....	.....	.....	9	150
Rhode Island.....	12 43	.....	.....	12	95	98	.....	.....	98	.....	.....	.....	.....	.....	139
South Carolina.....	269	.....	.....	.....	299	6	.....	.....	6	.....	.....	.....	.....	.....	638
South Dakota.....	30	.....	.....	17	85	166	20	11	177	.....	.....	.....	.....	.....	192
Tennessee.....	50	.....	.....	1	166	59	33	33	78	.....	.....	.....	.....	14	252
Texas.....	162	5	.....	47	521	194	30	62	194	.....	.....	.....	.....	.....	838
Utah.....	124	.....	.....	8	109	198	.....	29	290	.....	.....	.....	.....	37	309
Vermont.....	53	.....	.....	.....	.....	.....	.....	.....	29	.....	.....	.....	.....	.....	155
Virginia.....	61	13	.....	3	308	103	.....	.....	103	.....	.....	.....	.....	.....	427
Washington.....	54	63	.....	70	220	20	144	25	171	.....	.....	.....	.....	19	370
West Virginia.....	47	.....	.....	.....	89	37	.....	.....	37	.....	.....	.....	.....	.....	121
Wisconsin.....	253	.....	.....	52	748	1,681	.....	.....	1,831	.....	.....	.....	.....	.....	937
Wyoming.....	9	.....	.....	9	30	.....	.....	.....	.....	.....	.....	.....	.....	.....	94
Total.....	3,060	214	340	1,617	17,534	9,715	385	156	10,733	478	1,695	192	1,264	1,286	21,261

1 Total, counting none twice.

2 Three-year and shorter.

3 Including 30 students in four-year teachers' course.

4 Including 9 poultry students.

5 Students in poultry husbandry.

6 Sixty-three horticultural students included under agriculture.

7 Including 12 students in poultry husbandry.

8 Including 40 students in poultry husbandry.

9 Including 103 students in four-year course in industrial pedagogy.

10 Including 20 students in four-year teachers' course.

11 Including 75 students in poultry husbandry.

12 Including 13 students in four-year course of applied science for teachers.

TABLE 5.—General statistics and students, by classes, at land-grant colleges for colored students in 1910.

State or Territory.	Date of establishment of institution.	Date of establishment of agricultural course.	Faculty.			Graduates.			Library.		Students by classes.						
			College of agriculture and mechanic arts.		Other departments.	In 1909-10.		Total number since organization.	Number of volumes.	Number of pamphlets.	Number of acres in farm and grounds.	Preparatory.	College.	Short or special.	Other departments.	Total.	
			Preparatory classes.	College and special courses.		Total.	Number.										Average age.
Alabama (Normal).....	1875	1882	5	4	9	21	28	Y. M.	1,382	2,200	182	208	160	282	.....	341
Arkansas (Pine Bluff).....	1875	.....	7	8	8	2	23	20	235	3,400	20	118	183	.....	.....	301
Delaware (Dover).....	1892	1892	6	6	9	.....	9	.....	18	1,000	97	79	49	32	.....	160
Florida (Tallahassee).....	1887	1890	9	10	11	16	15	22	6	3,000	200	240	7	200	24	371	
Georgia (Savannah).....	1880	1890	12	4	16	.....	22	21	145	700	400	86	402	155	60	350
Kentucky (Frankfort).....	1887	1892	3	3	17	12	24	21	237	1,420	310	135	135	60	.....	395
Louisiana (New Orleans).....	1880	1890	9	8	17	.....	49	18	502	2,690	104	386	9	.....	.....	130
Maryland (Princess Ann).....	.....	.....	14	14	14	.....	10	18	114	1,000	118	130	.....	.....	.....	130
Mississippi (Alcorn).....	1871	1878	6	7	13	8	19	21	342	2,700	850	390	100	.....	10	500
Missouri (Jefferson City).....	1866	1866	1	1	.....	.....	20	23	516	3,000	40	113	.....	37	204	354
North Carolina (Greensboro).....	1891	1891	9	16	16	4	5	20	107	1,485	128	113	100	146	.....	3,363
Oklahoma (Langston).....	1897	1899	2	9	11	10	15	18	.....	1,533	320	85	5	117	386	593
South Carolina (Orangeburg).....	1896	1896	8	6	14	13	27	20	533	200	130	569	27	6	.....	602
Texas (Prairie View).....	.....	.....	8	7	15	12	87	23	756	2,400	1,490	366	247	.....	.....	613
Virginia (Hampton).....	1868	1890	11	101	112	.....	59	.....	1,631	27,000	1,160	1,170	180	.....	.....	41,374
West Virginia (Institute).....	1891	1892	14	21	21	.....	43	21	272	3,125	70	85	150	7	9	251
Total.....			124	207	290	122	435	20 5	7,062	56,833	5,305	4,589	1,382	787	633	7,110	

¹ Total, counting none twice.² Summer school for teachers.³ Including 4 postgraduate students.⁴ Including 14 postgraduate students.

TABLE 6.—Students, by courses, at land-grant colleges for colored students, in 1910.

State or Territory.	Agriculture.	Teachers' courses in agri- culture.		Carpentry.	Machine-shop work.	Blacksmithing.	Shoemaking.	Broom making.	Wheelwrighting.	Bricklaying.	Painting.	Printing.	Harness making.	Tailoring.	Plastering.	Sewing.	Cooking.	Laundering.	Nursing.	Millinery.	Military tactics.
		One to four years.	Sum in et school.																		
Alabama (Normal).....	46	.....	46	21	9	6	12	.....	6	14	5	12	.....	15	21	60	16	22	8	4	106
Arkansas (Pine Bluff).....	.....	.....	.....	70	24	48	.....	.....	.....	.....	.....	.....	.....	.....	.....	112	16	.....	.....	.....	159
Delaware (Dover).....	25	.....	.....	20	10	4	.....	.....	.....	.....	.....	4	.....	.....	.....	35	16	12	.....	.....	65
Florida (Tallahassee).....	111	.....	.....	17	.....	7	.....	.....	7	.....	.....	11	.....	17	.....	103	93	139	27	21	112
Georgia (Savannah).....	45	.....	.....	36	.....	31	44	.....	22	67	26	.....	.....	66	67	75	.....	.....	.....	.....	332
Kentucky (Frankfort).....	17	17	.....	33	.....	.....	.....	.....	.....	.....	.....	31	.....	.....	.....	201	20	75	.....	.....	123
Louisiana (New Orleans).....	40	.....	.....	65	.....	.....	.....	.....	4	.....	.....	20	.....	.....	.....	53	.....	35	.....	10	.....
Maryland (Princess Ann).....	50	10	.....	19	.....	5	.....	.....	.....	.....	.....	4	.....	.....	.....	73	57	7	.....	16	31
Mississippi (Alcorn).....	107	107	.....	80	39	30	35	.....	15	10	30	8	.....	.....	3	100	80	100	10	16	.....
Missouri (Jefferson City).....	77	.....	.....	59	29	19	.....	11	.....	.....	.....	.....	.....	.....	.....	161	105	178	.....	15	.....
North Carolina (Greensboro).....	72	4	44	33	33	33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	10	190
Oklahoma (Langston).....	305	5	.....	37	18	52	37	.....	52	81	83	.....	37	90	81	245	228	.....	.....	.....	.....
South Carolina (Orangeburg).....	21	.....	.....	37	52	52	15	.....	.....	.....	.....	.....	.....	7	.....	300	52	357	.....	65	287
Texas (Prairie View).....	139	.....	.....	75	6	50	7	.....	14	41	8	7	.....	37	.....	360	360	81	.....	.....	525
Virginia (Hampton).....	266	8	.....	40	10	25	.....	.....	8	13	3	6	.....	.....	13	92	213	74	5	6	93
West Virginia (Institute).....	10	.....	.....	17	.....	13	.....	.....	8	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total.....	1,331	151	90	651	187	389	150	11	133	236	188	99	72	232	185	2,277	1,316	1,031	49	163	2,025

TABLE 7.—*Value of permanent funds and*

	State or Territory.	Land-grant fund of 1862.	Other land-grant funds.	Other endowment funds.	Land grant of 1862 still unsold.	Farms and grounds owned by the institution.
1	Alabama (Auburn).....	\$253,000.00		\$31,000.00		\$9,000.00
2	Alabama (Normal).....					20,000.00
3	Arizona.....			10,500.00		31,290.00
4	Arkansas (Fayetteville).....	130,000.00				25,000.00
5	Arkansas (Pine Bluff).....					60,000.00
6	California.....	734,638.29	\$154,712.12	3,573,429.40	\$11,818.27	21,674,698.48
7	Colorado.....	142,230.88			125,000.00	225,000.00
8	Connecticut.....	135,000.00		61,000.00		27,500.00
9	Delaware (Newark).....	83,000.00				45,000.00
10	Delaware (Dover).....					7,000.00
11	Florida (Gainesville).....	153,800.00	38,000.00			150,000.00
12	Florida (Tallahassee).....					10,000.00
13	Georgia (Athens).....	242,202.07				445,000.00
14	Georgia (Savannah).....					6,776.25
15	Hawaii.....					100,000.00
16	Idaho.....	87,208.47	389,571.21		726,050.00	61,150.00
17	Illinois.....	647,131.53				410,000.00
18	Indiana.....	340,000.00				120,000.00
19	Iowa.....	686,777.97				147,797.20
20	Kansas.....	500,210.42			9,607.50	262,690.00
21	Kentucky (Lexington).....	144,075.00				225,000.00
22	Kentucky (Frankfort).....	20,925.00				25,100.00
23	Louisiana (Baton Rouge).....	182,313.03	136,000.00			151,040.00
24	Louisiana (New Orleans).....					50,000.00
25	Maine.....	118,300.00		100,000.00		11,000.00
26	Maryland (College Park).....	115,943.60				18,000.00
27	Maryland (Princess Anne).....					4,000.00
28	Massachusetts (Amherst).....	219,000.00		142,000.00		49,100.00
29	Massachusetts (Boston).....	^(c)		1,871,564.00		2,724,200.00
30	Michigan.....	986,338.49			76,000.00	74,400.00
31	Minnesota.....	571,000.00	877,799.00	50,000.00		1,833,958.33
32	Mississippi (Agricultural College).....	98,575.00	141,212.55	250.00		80,000.00
33	Mississippi (Alcorn).....	113,575.00	96,296.12			10,500.00
34	Missouri (Columbia) ⁶	349,881.19	222,000.00	684,958.23	60,000.00	523,550.00
35	Missouri (Jefferson City).....					7,000.00
36	Montana.....	7308,911.76	^(c)		175,392.58	63,000.00
37	Nebraska.....	491,988.46	180,283.68		50,000.00	550,000.00
38	Nevada.....	101,700.00	43,415.34		20,000.00	78,197.69
39	New Hampshire.....	80,000.00		870,000.00		31,000.00
40	New Jersey.....	116,000.00		677,593.81		165,000.00
41	New Mexico.....		21,656.76			37,475.00
42	New York.....	688,576.12		7,998,697.93		247,055.35
43	North Carolina (West Raleigh).....	125,000.00				70,310.80
44	North Carolina (Greensboro).....					27,000.00
45	North Dakota.....	920,073.18			454,962.00	48,000.00
46	Ohio.....	524,176.58	125,463.56	274,413.23		1,540,000.00
47	Oklahoma (Stillwater).....				1,000,000.00	50,000.00
48	Oklahoma (Langston).....					16,000.00
49	Oregon.....	196,519.00			55,000.00	356,000.00
50	Pennsylvania.....	427,290.50		87,709.50		52,800.00
51	Porto Rico.....					32,783.40
52	Rhode Island.....	50,000.00				14,855.00
53	South Carolina (Clemson College).....	95,900.00		58,539.00		58,105.67
54	South Carolina (Orangeburg).....	95,900.00				40,000.00
55	South Dakota.....	70,086.82			1,600,600.00	65,000.00
56	Tennessee.....	400,000.00	5,000.00	2,000.00		285,475.00
57	Texas (College Station).....	209,000.00				120,800.00
58	Texas (Prairie View).....					17,500.00
59	Utah.....	143,080.70			45,984.94	25,200.00
60	Vermont.....	135,500.00		576,396.00		76,000.00
61	Virginia (Blacksburg).....	344,312.00				61,200.00
62	Virginia (Hampton).....	172,156.00			2,273,822.93	77,500.00
63	Washington.....	168,463.00	348,775.00		1,601,240.00	110,900.00
64	West Virginia (Morgantown).....	115,104.17		1,600.00		250,000.00
65	West Virginia (Institute).....					15,600.00
66	Wisconsin.....	303,558.61	232,596.50	90,006.15	940.00	1,526,010.25
67	Wyoming.....	23,194.02			900,000.00	105,000.00
	Total.....	13,361,616.86	3,012,781.84	17,161,657.25	9,185,818.22	15,838,518.42

¹Including machinery.²Including farm buildings.³Including real estate.⁴Including apparatus.⁶Included under Massachusetts Agricultural College.

equipment of land-grant colleges, 1910.

Buildings.	Apparatus.	Machinery.	Library.	Live stock.	Miscellaneous.	Total.	
\$352,878.66	\$34,202.87	\$39,040.00	\$101,216.98	\$3,000.00	-----	\$823,338.51	1
80,000.00	125,000.00	-----	900.00	800.00	-----	126,700.00	2
204,659.63	41,094.71	21,823.99	30,042.00	1,545.00	-----	340,955.33	3
350,000.00	75,000.00	85,000.00	40,000.00	5,000.00	\$2,000.00	712,000.00	4
28,000.00	600.00	16,000.00	2,000.00	-----	700.00	107,300.00	5
³ 5,135,171.95	-----	-----	-----	-----	-----	1,284,468.51	6
263,251.00	78,500.00	21,516.60	40,000.00	1,000.00	25,000.00	921,498.48	7
261,150.00	12,000.00	7,000.00	21,000.00	11,000.00	40,000.00	575,650.00	8
135,000.00	65,000.00	20,000.00	27,500.00	5,500.00	1,800.00	382,800.00	9
26,000.00	1,000.00	800.00	300.00	1,300.00	-----	36,400.00	10
180,000.00	30,000.00	32,000.00	10,000.00	4,000.00	2,000.00	599,800.00	11
35,000.00	8,200.00	3,050.00	2,500.00	3,250.00	4,800.00	66,800.00	12
494,200.00	31,266.90	1,635.12	52,500.00	3,945.68	24,234.10	1,294,983.87	13
49,452.77	250.00	2,034.55	551.06	885.00	-----	59,949.63	14
17,184.00	30,589.00	3,383.00	13,379.00	-----	4,169.00	168,704.00	15
405,730.00	39,060.73	24,361.92	34,362.74	5,664.40	23,234.64	1,796,394.11	16
1,893,500.00	378,025.65	58,514.06	328,003.02	27,204.00	383,033.00	4,125,411.26	17
1,025,000.00	-----	⁴ 260,000.00	53,000.00	10,000.00	30,000.00	1,838,000.00	18
1,542,600.50	436,495.00	60,000.00	108,618.00	4,500.00	139,000.00	3,125,788.67	19
701,518.00	54,024.00	57,141.00	60,617.00	33,652.00	183,491.00	1,862,950.92	20
541,000.00	49,288.00	18,051.00	34,267.00	-----	33,398.00	1,045,079.00	21
75,000.00	500.00	2,300.00	750.00	1,221.25	6,000.00	131,796.25	22
520,245.19	32,369.56	27,274.58	38,077.47	400.00	32,107.79	1,119,827.62	23
48,160.82	3,642.10	3,880.30	4,075.00	1,365.00	5,400.00	116,523.22	24
440,606.37	-----	⁴ 104,674.52	41,257.25	6,411.55	24,544.97	846,794.66	25
200,000.00	47,000.00	12,000.00	8,000.00	4,000.00	-----	404,943.60	26
20,000.00	1,000.00	2,600.00	600.00	2,300.00	200.00	30,700.00	27
401,950.60	72,123.46	4,650.00	55,600.00	17,848.00	64,558.14	1,026,830.20	28
628,800.00	-----	⁴ 393,530.00	182,315.90	-----	-----	5,800,409.90	29
851,375.00	90,000.00	70,000.00	62,517.38	33,042.00	-----	2,243,672.87	30
2,562,272.52	363,266.00	113,366.00	450,000.00	39,806.00	400,807.00	7,262,274.85	31
500,245.00	38,758.42	136,748.46	28,474.41	37,660.00	73,304.07	1,135,227.91	32
220,000.00	10,000.00	6,000.00	3,500.00	4,600.00	-----	464,471.12	33
1,220,040.00	192,195.00	45,767.00	169,961.00	27,000.00	2,516.00	3,497,868.42	34
110,000.00	600.00	5,000.00	3,000.00	300.00	500.00	126,400.00	35
290,000.00	60,000.00	17,500.00	20,000.00	7,930.00	22,000.00	964,734.34	36
948,500.00	90,000.00	35,000.00	167,500.00	30,000.00	235,000.00	2,778,272.14	37
406,210.44	49,931.26	18,485.86	32,220.28	10,437.89	101,041.46	861,640.22	38
351,000.00	41,000.00	10,000.00	28,000.00	5,000.00	22,500.00	1,438,500.00	39
590,000.00	48,000.00	-----	60,000.00	-----	90,000.00	1,740,593.81	40
107,900.00	26,000.00	42,000.00	37,395.80	5,540.00	-----	277,967.56	41
4,119,782.78	-----	-----	740,416.00	-----	⁹ 1,254,096.71	15,048,624.89	42
324,674.37	29,662.00	102,500.00	8,000.00	5,857.05	44,965.13	710,969.35	43
79,510.00	2,861.00	17,151.00	2,865.17	3,593.00	11,520.61	144,500.78	44
402,970.00	45,000.00	24,000.00	25,000.00	13,000.00	65,000.00	1,998,005.18	45
1,598,000.00	350,000.00	100,000.00	300,000.00	15,000.00	-----	4,827,053.37	46
341,000.00	153,935.00	10,000.00	24,572.00	11,875.00	-----	1,591,382.00	47
106,500.00	4,500.00	10,500.00	2,300.00	2,000.00	6,000.00	147,800.00	48
508,250.00	¹ 146,410.93	-----	20,000.00	6,200.00	-----	1,288,379.93	49
1,374,419.00	¹ 150,000.00	70,000.00	11,913.00	-----	-----	2,174,132.00	50
64,857.14	4,536.27	1,697.24	3,341.80	7,500.67	7,988.89	122,705.41	51
189,616.57	-----	-----	27,140.01	4,020.00	82,701.79	368,333.37	52
579,200.00	-----	297,829.00	23,910.70	17,991.50	-----	1,131,475.87	53
92,500.00	11,500.00	7,150.00	139.45	3,880.00	2,500.00	253,569.45	54
300,000.00	25,000.00	19,000.00	36,000.00	10,000.00	3,750.00	2,128,836.82	55
301,537.83	82,673.50	73,551.26	23,102.00	6,556.00	26,435.00	1,206,330.59	56
778,000.00	43,055.45	17,756.55	15,756.00	21,100.00	68,000.00	1,333,468.00	57
152,500.00	3,000.00	5,000.00	2,250.00	3,850.00	1,200.00	185,300.00	58
333,000.00	36,000.00	25,212.87	15,800.00	13,635.00	36,309.20	674,222.71	59
940,000.00	55,000.00	30,000.00	120,766.00	10,000.00	200,000.00	2,143,662.00	60
483,000.00	-----	-----	7,800.00	-----	⁹ 125,000.00	1,021,312.00	61
740,000.00	-----	-----	11,000.00	19,858.00	¹⁰ 176,000.00	3,470,336.93	62
1,006,563.00	¹ 131,435.13	67,213.22	67,213.22	15,000.00	37,332.86	3,486,922.21	63
606,000.00	25,100.00	52,350.00	65,027.00	5,085.00	10,400.00	1,130,666.17	64
117,600.00	5,000.00	15,450.00	5,000.00	1,908.00	1,200.00	161,758.00	65
2,536,218.78	413,054.27	24,571.55	352,988.40	28,414.58	177,967.47	5,686,320.56	66
289,000.00	95,000.00	38,000.00	54,000.00	7,300.00	15,000.00	1,526,494.02	67
42,578,301.92	4,368,706.21	2,693,847.43	4,378,389.04	602,644.57	4,330,706.83	117,512,988.59	

⁶ Including the School of Mines at Rolla.⁷ Including other land-grant funds.⁸ Included in land-grant fund of 1862.⁹ Including apparatus, machinery, and live stock.¹⁰ Including apparatus and machinery

TABLE 8.—*Revenue of land-grant col*

	State or Territory.	Federal aid.			State aid.	
		Interest on land grant of 1862.	Interest on other land grants.	Appropriation acts of 1890 and 1907.	Interest on endowment or regular appropriation.	Appropriation for current expenses.
1	Alabama (Auburn).....	\$20,280.00		\$22,118.82	\$36,000.00	\$38,700.00
2	Alabama (Normal).....			17,881.18	4,000.00	
3	Arizona.....	1,500.00		40,000.00		35,500.00
4	Arkansas (Payetteville).....	3,900.00		29,030.91		99,000.00
5	Arkansas (Pine Bluff).....			10,909.09		11,600.00
6	California.....	38,538.79	\$8,145.29	40,000.00	39,486.00	738,356.89
7	Colorado.....	7,966.87		40,000.00		83,324.73
8	Connecticut.....	6,750.00		40,000.00		25,000.00
9	Delaware (Newark).....	4,980.00		32,000.00		5,000.00
10	Delaware (Dover).....			8,000.00		
11	Florida (Gainesville).....	4,994.00	2,126.00	20,000.00		20,000.00
12	Florida (Tallahassee).....			20,000.00		5,000.00
13	Georgia (Athens).....	16,954.14		26,666.66		54,999.98
14	Georgia (Savannah).....			13,333.34	8,000.00	
15	Hawaii.....			40,000.00		7,500.00
16	Idaho.....	11,397.27	33,014.77	40,000.00		39,750.00
17	Illinois.....	32,414.44		40,000.00		525,000.00
18	Indiana.....	17,000.00		40,000.00		189,101.77
19	Iowa.....	34,412.98		40,000.00		242,500.00
20	Kansas.....	28,787.11		40,000.00		175,000.00
21	Kentucky (Lexington).....	8,644.50		34,200.00		67,980.15
22	Kentucky (Frankfort).....	1,252.50		5,500.00		8,000.00
23	Louisiana (Baton Rouge).....	9,115.69	5,440.00	22,148.65		51,500.00
24	Louisiana (New Orleans).....			17,851.35		10,000.00
25	Maine.....	5,915.00		40,000.00		4,133,000.00
26	Maryland (College Park).....	5,797.18		32,000.00		16,000.00
27	Maryland (Princess Anne).....			8,000.00		
28	Massachusetts (Amherst).....	7,300.00		26,666.67	3,313.32	83,875.00
29	Massachusetts (Boston).....	5,306.68		13,333.33	29,000.00	
30	Michigan.....	71,109.49		40,000.00		145,000.00
31	Minnesota.....	24,345.00		40,000.00	37,614.00	454,223.10
32	Mississippi (Agricultural College).....	5,914.50	8,472.75	20,288.46		134,490.03
33	Mississippi (Alcorn).....	6,814.50	5,777.77	19,711.54		8,000.00
34	Missouri (Columbia).....	17,494.08	12,320.00	37,500.00	32,997.90	6,319,953.07
35	Missouri (Jefferson City).....			2,500.00		(e)
36	Montana.....	7,28,232.07		40,000.00		8,958.25
37	Nebraska.....	28,000.00	14,000.00	40,000.00		271,236.00
38	Nevada.....	4,580.20	3,949.23	40,000.00		65,600.00
39	New Hampshire.....	4,800.00		40,000.00		12,890.00
40	New Jersey.....	5,800.00		40,000.00		29,625.58
41	New Mexico.....		2,990.52	40,000.00		18,609.36
42	New York.....	34,428.80		40,000.00		230,544.73
43	North Carolina (West Raleigh).....	7,500.00		26,800.00		70,000.00
44	North Carolina (Greensboro).....			13,200.00		10,000.00
45	North Dakota.....	58,529.76		40,000.00		55,910.70
46	Ohio.....	31,450.59	7,044.72	40,000.00		451,471.81
47	Oklahoma (Stillwater).....	30,690.00		36,000.00		95,845.73
48	Oklahoma (Langston).....			4,000.00		42,500.00
49	Oregon.....	12,115.15		40,000.00		65,000.00
50	Pennsylvania.....	25,637.00		40,000.00	5,383.00	216,845.00
51	Porto Rico.....			40,000.00		67,655.92
52	Rhode Island.....	2,500.00		40,000.00		25,000.00
53	South Carolina (Clemson College).....	5,754.00		20,000.00	161,994.23	
54	South Carolina (Orangeburg).....	5,872.59		20,000.00		4,934.44
55	South Dakota.....	20,718.12		40,000.00		45,800.00
56	Tennessee.....	23,960.00	250.00	40,000.00		38,545.92
57	Texas (College Station).....	12,180.00		30,000.00		87,650.00
58	Texas (Prairie View).....			10,000.00		32,000.00
59	Utah.....	7,493.64		40,000.00		70,600.00
60	Vermont.....	4,065.00	3,680.00	40,000.00		16,000.00
61	Virginia (Blacksburg).....	20,658.72		26,666.67		60,000.00
62	Virginia (Hampton).....	10,329.36		13,333.33		1,819.87
63	Washington.....	11,000.00	18,000.00	40,000.00		267,268.00
64	West Virginia (Morgantown).....	6,485.00		32,000.00		131,600.00
65	West Virginia (Institute).....			8,000.00		28,750.00
66	Wisconsin.....	11,777.56	11,657.43	40,000.00		896,585.00
67	Wyoming.....		6,175.81	40,000.00		31,508.16
Total.....		812,462.28	143,044.29	2,000,000.00	357,788.45	7,178,109.19

¹ Lease of lands.² Including \$7,500 for farmers' institutes.³ For farmers' institutes.⁴ Including new dormitory.

leges for year ended June 30, 1910.

State aid.	Income from endowment other than Federal or State grants.	Fees and all other sources.			Total.	United States appropriations for experiment stations (acts of 1887 and 1906).	
		Tuition and incidental fees.	Private benefactions.	Miscellaneous.			
\$56,000.00		\$11,019.65		\$5,531.17	\$189,649.64	\$28,000.00	1
		285.00		2,437.08	24,603.26		2
11,500.00	\$520.00	3,672.65		19,456.66	111,149.31	28,000.00	3
13,000.00		11,496.00	\$525.00	20,801.82	177,813.73	28,000.00	4
		550.00			23,059.09		5
270,478.79	148,846.59	117,323.99	1,239,944.00	88,413.01	2,729,553.35	28,000.00	6
56,372.38				13,788.68	201,452.66	28,000.00	7
9,101.56	6,060.00	3,638.00		73,754.45	164,304.01	14,000.00	8
		1,275.00		8,083.49	51,338.49	28,000.00	9
				5,488.00	13,488.00		10
* 97,500.00		1,687.50	1,150.00	11,893.07	159,550.57	28,000.00	11
				10,620.92	35,620.92		12
* 2,500.00		657.00		8,148.45	109,926.23		13
					21,333.34		14
4,000.00			1,440.00		52,940.00		15
26,000.00		338.25		4,098.07	154,598.36	28,000.00	16
523,500.00		203,161.44		119,716.18	1,443,792.06	28,000.00	17
158,907.70		61,572.50	2,009.92	13,855.92	482,447.81	28,000.00	18
161,618.70	4.20	58,244.65	1,900.00	3,665.02	542,345.55	28,000.00	19
60,000.00		15,970.00		44,718.94	364,476.05	28,000.00	20
		5,531.67		58,067.44	174,423.76	28,000.00	21
6,800.00		78.81		7,367.72	29,299.03		22
25,600.00		7,818.75		19,219.79	140,842.88	28,000.00	23
750.00				843.07	29,444.42		24
	4,000.00	40,224.50		19,782.16	242,921.66	28,000.00	25
40,000.00		29,079.64		8,240.00	131,116.82	28,000.00	26
		1,450.00		1,012.00	10,462.00		27
105,664.24		540.00		110,197.63	337,556.86	28,000.00	28
		341,195.54	137,307.51	19,828.78	545,971.84		29
41,550.69		23,047.60	500.00	66,613.42	387,821.20	28,000.00	30
611,507.90		164,438.00	70,000.00	27,296.00	1,429,424.00	28,000.00	31
48,500.00		9,568.00	250.00	183,598.35	411,082.09	28,000.00	32
					16,243.58		33
20,099.23	300.00	38,950.00		110,190.62	589,804.00	28,000.00	34
					2,590.00		35
60,000.00		5,793.35		6,646.29	149,539.96	28,000.00	36
85,300.00		62,638.00	1,000.00	52,729.09	554,903.00	28,000.00	37
	6,064.00		16,000.00	17,648.24	153,841.67	28,000.00	38
19,540.13	11,493.93	5,616.85		30,196.08	124,536.99	28,000.00	39
	32,870.19	19,751.76	38,172.13	6,084.20	172,303.86	28,000.00	40
		1,695.00		15,020.98	78,315.86	28,000.00	41
51,142.86	406,117.72	339,709.49	228,544.37	313,244.28	1,643,792.25	25,200.00	42
18,000.00		13,872.50		68,342.05	204,514.55	28,000.00	43
4,350.00		540.52		10,286.57	38,377.09		44
		5,181.00		10,555.04	170,176.50	28,000.00	45
225,000.00	16,267.47	90,201.75	650.00	70,337.88	932,424.22		46
56,600.00				3,933.58	223,069.31	28,000.00	47
					46,500.00		48
210,000.00		17,826.46		6,905.93	351,847.54	28,000.00	49
2,880.00	2,500.00	94,266.00	1,354.00	221,944.00	610,809.00	28,000.00	50
				5,477.47	113,133.39		51
7,750.00		2,820.35		31,398.09	109,468.44	28,000.00	52
	3,512.36	2,470.00		75,116.04	268,846.63	28,000.00	53
19,350.00		649.00		31,037.21	81,843.24		54
28,300.00		8,117.50		3,963.74	146,599.36	28,000.00	55
	1,956.53	45,235.32	2,215.92	19,567.85	171,731.54	28,000.00	56
			535.00		130,365.00	28,000.00	57
6,750.00		6,000.00		54,000.00	108,750.00		58
28,100.00		7,346.50		3,770.80	157,310.94	28,000.00	59
	27,856.00	50,818.00	30,400.00	24,562.00	197,381.00	28,000.00	60
		2,218.00		145,918.80	255,462.19	28,000.00	61
	86,808.59	2,464.03		240,228.87	354,984.05		62
		175.00		45,011.71	381,454.71	28,000.00	63
30,000.00		23,598.64	85.00	21,004.01	244,772.65	28,000.00	64
		321.00		8,647.65	45,718.65		65
275,019.27	4,610.89	212,529.14	17,881.87	194,793.37	1,664,854.53	28,000.00	66
26,139.77	18.30	1,998.50		6,651.89	112,492.43	28,000.00	67
3,504,873.22	759,806.77	2,176,637.80	1,791,864.72	2,847,995.11	21,572,581.83	1,271,200.00	

* The available residue of the biennial appropriation for 1909 and 1910.

* Biennial appropriation for 1909 and 1910 included in last year's report.

* Including income from other land grants.

TABLE 9.—*Additions to equipment of land-grant colleges, 1910.*

State or Territory.	Permanent endowment.	Buildings.	Library.	Apparatus.	Machinery.	Live stock.	Miscellaneous.	Total.
Alabama (Auburn).....	\$20,280.00	\$24,368.40	\$2,638.00	\$6,518.57	\$124.34	.....	.....	\$63,929.31
Alabama (Normal).....	2,180.00	546.00	700.00	34.00	\$20.00	.....	\$3,000.00
Arizona.....	7,462.74	3,000.00	4,008.03	241.55	325.00	\$500.00	15,317.32
Arkansas (Fayetteville).....	2,500.00	900.00	3,000.00	4,000.00	1,000.00	460.00	11,860.00
Arkansas (Pine Bluff).....
California.....	1,183,620.19	455,026.08	21,172.69	.....	179,300.19	7,557.20	60,022.25	1,806,678.60
Colorado.....	56,366.16	.....	22,500.00	1,000.00	.....	.....	79,866.16
Connecticut.....	1,299.31	387.76	3,243.21	483.11	793.40	6,732.78	12,933.57
Delaware (Newark).....	3,000.00	2,311.88	4,489.73	1,576.28	990.00	2,474.90	14,842.79
Florida (Gainesville).....	400.00	.....	200.00	55.00	655.00
Florida (Tallahassee).....	90,239.93	2,272.71	3,300.06	700.00	250.00	1,319.65	97,832.35
Georgia (Athens).....	200.00	700.00	750.00	.....	.....	2,900.00
Georgia (Savannah).....	2,500.00	5,601.00	.....	1,016.15	5,000.00	14,117.15
Hawaii.....	1,400.00	.....	.....	.....	.....	.....	2,288.00
Idaho.....	80,815.72	4,088.00	3,379.65	17,434.10	3,883.16	.....	4,169.01	82,953.92
Illinois.....	1,960.00	32,829.51	8,159.89	6,118.62	4,099.12	2,139.40	3,159.41	137,351.67
Indiana.....	400,000.00	50,000.00	25,000.00	10,000.00	8,000.00	10,000.00	504,960.00
Iowa.....	178,000.00	3,000.00	10,000.00	.....	2,000.00	3,000.00	196,000.00
Iowa.....	76,500.00	5,000.00	15,600.00	5,000.00	10,000.00	30,000.00	196,000.00
Kansas.....	60,000.00	1,000.00	3,400.00	3,500.00	8,886.50	46,000.00	122,786.50
Kansas.....	4,842.27	5,002.94	2,346.79	.....	5,172.60	17,364.60
Kentucky (Lexington).....	15,287.58	400.00	3,663.57	988.55	250.00	100.00	500.00
Kentucky (Frankfort).....	1,583.19	.....	400.00	.....	4,763.24	26,536.13
Louisiana (Baton Rouge).....	23,144.85	75.00	175.00	.....	408.00	400.00	1,050.00
Louisiana (New Orleans).....	55,000.00	900.00	.....	800.00	480.00	.....	28,181.03
Maine.....	180.00	88.00	260.00	100.00	2,000.00	59,180.00
Maryland (College Park).....	110,000.00	.....	10,000.00	.....	100.00	400.00	1,028.00
Maryland (Princess Anne).....	38,500.00	158,500.00
Massachusetts (Amherst).....
Massachusetts (Boston).....
Michigan.....	25,000.00	2,500.00	30,000.00	5,000.00	3,000.00	.....	65,500.00
Minnesota.....	94,331.00	24,170.00	7,400.00	1,929.00	4,673.83	312,557.87	480,043.70
Mississippi (Agricultural College).....	73,602.48	2,507.95	3,981.31	4,926.61	6,700.00	8,040.96	99,759.31
Mississippi (Alcorn).....
Missouri (Columbia).....	15,000.00	1,264.00	.....	4,000.00	1,000.00	26,264.00
Missouri (Jefferson City).....	1,000.00	.....	200.00	150.00	.....	11,350.00
Montana.....	48,888.12	60,000.00	1,500.00	4,500.00	775.00	1,000.00	.....	116,663.12
Nebraska.....	25,000.00	10,000.00	10,000.00	30,000.00	7,500.00	6,650.00	89,150.00
Nevada.....	6,921.58	8,789.12	12,273.60	832.16	1,287.30	7,531.84	37,635.60
New Hampshire.....	18,500.00	1,375.00	10,970.00	350.00	.....	945.00	32,100.00
New Jersey.....	10,805.00	41,780.80	3,939.95	1,169.25	757.16	250.00	501.00	59,203.16
New Mexico.....	1,326.80	3,677.22	1,225.34	785.00	.....	7,014.36
New York.....	46,911.47	58,799.00	21,550.00	5,050.00	1,009.00	258.00	238,638.87	165,607.34
North Carolina (West Raleigh).....	54,774.37	500.00	.....	213.00	428.00	1,000.00	61,333.37
North Carolina (Greensboro).....	1,650.00	4,350.00	703.66	300.00	.....	.....	.....	8,644.66

North Dakota.....	128,831.84	2,090.19	5,840.84	1,832.10	6,148.38	4,036.49	148,779.84
Ohio.....	114,673.24	23,286.52	3,532.86	.....	6,200.12	32,000.00	245,538.16
Oklahoma (Stillwater).....	56,600.00	1,862.00	3,935.00	.....	11,875.00	.....	74,272.00
Oklahoma (Langston).....	500.00	3,850.00	2,700.00	.....	250.00	500.00	5,300.00
Oregon.....	130,000.00	3,100.00	.....	152,900.00	4,000.00	20,000.00	210,000.00
Pennsylvania.....	7,000.00	5,500.00	.....	.....	2,431.17	.....	14,931.17
Porto Rico.....	4,978.00	454.10	1,732.11	1,212.69	1,550.00	3,183.86	13,170.76
Rhode Island.....	4,200.00	710.41	3,467.51	124.83	838.60	1,300.00	10,641.35
South Carolina (Clemson College).....	6,721.24	889.59	.....	19,974.34	1,722.16	.....	19,307.33
South Carolina (Orangeburg).....	.....	100.00	.....	497.50*	880.00	.....	1,516.95
South Dakota.....	28,000.00	300.00	1,500.00	.....	2,200.00	.....	32,000.00
Tennessee.....	12,191.24	2,385.00	8,470.00	5,210.00	1,315.00	2,317.00	31,888.24
Texas (College Station).....	2,500.00	600.00	8,000.00	4,000.00	1,250.00	2,000.00	18,350.00
Texas (Prairie View).....	2,500.00	250.00	3,000.00	1,000.00	.....	.....	6,750.00
Utah.....	35,672.46	1,300.00	6,433.84	912.87	5,812.16	6,609.20	56,740.53
Vermont.....	.....	6,000.00	2,500.00	.....	.....	.....	95,542.00
Virginia (Blacksburg).....	4,612.00	500.00	2,000.00	1,000.00	.....	.....	8,112.00
Virginia (Hampton).....	40,000.00	1,000.00	1,000.00	.....	5,475.00	.....	517,445.35
Washington.....	76,118.39	16,113.22	8,058.24	5,226.89	5,404.63	35,732.86	422,994.44
West Virginia (Morgantown).....	6,000.00	2,027.00	5,100.00	4,350.00	.....	.....	17,477.00
West Virginia (Institute).....	.....	250.00	350.00	4,950.00	.....	350.00	1,900.00
Wisconsin.....	209,165.89	34,335.65	33,531.90	4,094.11	1,651.58	41,145.04	330,128.86
Wyoming.....	19,413.54	2,302.29	5,520.38	479.24	1,565.72	2,336.85	31,620.02
Total.....	2,290,541.49	319,853.67	396,878.58	201,634.93	134,959.30	753,403.13	7,130,832.73

* Including apparatus.

Including apparatus, machinery, and live stock.

* Including machinery.

South Carolina.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
South Dakota.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
Tennessee.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
Texas.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
Utah.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
Vermont.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
Virginia.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
Washington.....	.....	.....	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
West Virginia.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
Wisconsin.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
Wyoming.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000	45,000
Total.....	660,000	704,000	782,000	864,000	912,000	960,000	1,008,000	1,056,000	1,104,000	1,152,000	1,200,000	1,440,000	1,750,000	2,000,000	2,250,000

¹ From the annual statement of the Commissioner of Education to the Secretary of the Interior, 1910.

² For each of the years ended June 30, 1901, 1902, 1903, 1904, 1905, 1906, and 1907 the sum of \$25,000 was paid to each of the 48 States and Territories included in this tabular statement, the total amount disbursed for each of said years being \$1,200,000.

STATISTICS OF THE AGRICULTURAL

TABLE 11.—*Gener*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Alabama (College).....	Auburn.....	J. F. Duggar, M. S.....	Feb. —, 1883	Feb. 24, 1888
Alabama (Canebrake).....	Uniontown.....	F. D. Stevens, B. S.....	Jan. 1, 1886	Apr. 1, 1888
Alabama.....	Tuskegee Institute.	G. W. Carver, M. S. Agr.....	Feb. 15, 1897	.....
Arizona.....	Tucson.....	R. H. Forbes, M. S.....	.....	— —, 1889
Arkansas.....	Fayetteville.....	C. F. Adams, B. Agr., A. M., M. D.	.....	Mar. 7, 1889
California.....	Berkeley.....	E. J. Wickson, A. M.....	— —, 1873	Mar. —, 1888
Colorado.....	Fort Collins.....	L. G. Carpenter, M. S.....	.....	Feb. —, 1888
Connecticut (State).....	New Haven.....	E. H. Jenkins, Ph. D.....	Oct. 1, 1875	May 18, 1887
Connecticut (Storrs).....	Storrs.....	L. A. Clinton, M. S.....	.....	May 18, 1887
Delaware.....	Newark.....	Harry Hayward, M. S. Agr.....	.....	Feb. 21, 1888
Florida.....	Gainesville.....	P. H. Rolfs, M. S.....	.....	— —, 1888
Georgia.....	Experiment.....	M. V. Calvin.....	Feb. 18, 1888	July 1, 1889
Idaho.....	Moscow.....	W. L. Carlyle, M. S.....	.....	Feb. 26, 1892
Illinois.....	Urbana.....	Eugene Davenport, M. Agr., LL. D.	.....	Mar. 21, 1888
Indiana.....	Lafayette.....	Arthur Goss, M. S., A. C.....	.....	Jan. 1, 1888
Iowa.....	Ames.....	C. F. Curtiss, M. S., A. D. S.....	.....	Feb. 17, 1888
Kansas.....	Manhattan.....	E. H. Webster, B. Agr., M. S.....	.....	Feb. 8, 1888

EXPERIMENT STATIONS.

ai statistics, 1910.

Number on staff. ¹	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1910.		Number of names on mailing list.	Principal lines of work.
			Number.	Pages.		
19	15	13	10	229	17,500	Field experiments; horticulture; plant breeding; soil improvement; feeding experiments; entomology; diseases of plants and animals; analyses of fertilizers.
1	.....	1	1	16	2,000	Soil improvement; field experiments; plant breeding; diseases of plants.
24	24	24	4	77	1,900	Field experiments; horticulture; plant breeding; diseases of plants; animal industry; poultry investigations; dairying.
13	2	4	8	336	8,776	Botany; field experiments; improvement of ranges; horticulture, including date-palm culture; sheep-breeding experiments; plant breeding; irrigation; dry farming.
20	13	6	6	109	25,000	Chemistry; soil physics; field experiments; horticulture; plant breeding; diseases of plants; animal husbandry and pathology; feeding and breeding experiments; entomology; nursery inspection; dairying; poultry experiments.
55	22	19	13	308	15,000	Chemistry; soils; bacteriology; fertilizer control; field experiments; horticulture, viticulture, and zymology; botany; meteorology; animal husbandry; entomology; dairying; poultry culture; drainage and irrigation; silviculture; reclamation of alkali lands; animal and plant pathology; nutrition investigations.
28	9	17	19	490	18,870	Chemistry; meteorology; field experiments; horticulture; forestry; plant breeding; diseases of plants; animal husbandry; poultry investigations; veterinary investigations; entomology; bacteriology; irrigation.
18	.....	4	3	424	9,000	Chemistry; analysis and inspection of fertilizers, foods, drugs, and feeding stuffs; inspection of Babcock-test apparatus and nurseries; diseases of plants; plant selection and breeding; seed testing; forestry; field experiments; entomology; investigation of vegetable proteids.
12	6	5	6	682	9,000	Dairy and soil bacteriology; field experiments; horticulture; feeding and breeding experiments; poultry experiments and diseases; dairying, including soft-cheese manufacture; embryology.
10	4	5	4	90	8,000	Chemistry; field experiments; horticulture; diseases of plants and animals; animal husbandry.
14	.....	1	5	175	15,000	Chemistry; soils; field experiments; horticulture; plant physiology; diseases of plants; feeding experiments; entomology.
8	.....	.....	6	96	1,100	Chemistry; field experiments; bacteriology; horticulture; plant breeding; plant and animal diseases; entomology; feeding experiments; dairying.
19	8	9	.....	.....	5,348	Chemistry; physics; bacteriology; botany; field experiments; horticulture; plant breeding and diseases; entomology; animal husbandry; irrigation; dairying; dry farming; wheat investigations.
63	24	24	25	710	43,000	Soil chemistry; soil physics; bacteriology; pot and field experiments; horticulture; plant breeding; animal husbandry; diseases of plants and animals; dairying.
50	11	14	23	1,022	35,007	Chemistry; soils; field experiments; feeding experiments; horticulture; plant breeding; diseases of plants and animals; entomology; dairying; feeding stuff and fertilizer control; agricultural extension work.
37	13	.....	19	480	14,800	Chemistry; botany; soils; field experiments; horticulture; plant breeding; forestry; diseases of plants; animal husbandry; poultry investigations; entomology; dairying; rural engineering; good-roads investigations.
55	33	21	17	337	19,000	Soils; inspection of feeding stuffs and fertilizer control; horticulture; plant breeding; forestry; field experiments; feeding and digesting experiments; milling and baking tests; correlation of characteristics of wheat; poultry experiments; diseases of animals; hog-cholera serum; entomology; dairying; extermination of prairie dogs and gophers; irrigation.

¹ Including substations.

TABLE 11.—*General sta*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Kentucky.....	Lexington.....	M. A. Scovell, M. S., Ph. D....	Sept. —, 1885	Apr. —, 1888
Louisiana (Sugar)...	New Orleans.....	W. R. Dodson, A. B., B. S.	Sept. —, 1885	} — —, 1888 July 1, 1908
Louisiana (State)...	Baton Rouge.....	do.....	Apr. —, 1886	
Louisiana (North)...	Calhoun.....	do.....	May —, 1887	
Louisiana (Rice)...	Crowley.....	do.....		
Maine.....	Orono.....	C. D. Woods, Sc. D.....	Mar. —, 1885	Oct. 1, 1887
Maryland.....	College Park.....	H. J. Patterson, B. S.....	— —, 1888	Mar. 9, 1888
Massachusetts.....	Amherst.....	W. P. Brooks, Ph. D.....	² — —, 1882	Mar. 2, 1888
Michigan.....	East Lansing.....	R. S. Shaw, B. S. A.....		Feb. 26, 1888
Minnesota.....	St. Anthony Park, St. Paul.	A. F. Woods, M. A.....	Mar. 7, 1885	— —, 1888
Mississippi.....	Agricultural Col- lege.	W. L. Hutchinson, M. S.....		Jan. 27, 1888
Missouri (College)...	Columbia.....	F. B. Mumford, M. S.....		Jan. —, 1888
Missouri (Fruit)...	Mountain Grove...	Paul Evans.....	Feb. 1, 1900	
Montana.....	Bozeman.....	F. B. Linfield, B. S. A.....		July 1, 1893
Nebraska.....	Lincoln.....	E. A. Burnett, B. S.....	Dec. 16, 1884	June 14, 1887
Nevada.....	Reno.....	J. E. Stubbs, M. A., D. D., LL. D.		Dec. —, 1887
New Hampshire.....	Durham.....	E. D. Sanderson, B. S. A.....		Aug. 4, 1887
New Jersey (State).	New Brunswick....	E. B. Voorhees, D. Sc.....	Mar. 10, 1880	
New Jersey (Col- lege).	do.....	do.....		Apr. 26, 1888

¹ Including substations.² In 1882 the State organized a station here and maintained it until June 18, 1895, when it was combined with the Hatch station at the same place.

istics, 1910—Continued.

Number on staff. ¹	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1910.		Number of names on mailing list.	Principal lines of work.
			Number.	Pages.		
28	2	5	6	278	13,500	Chemistry; soils; bacteriology; inspection of fertilizers, foods, feeding stuffs, seeds, orchards, and nurseries; field experiments; horticulture; plant breeding; animal husbandry; diseases of plants and animals; entomology; apiculture; dairying.
23	3	13	8	639	13,000	Chemistry; bacteriology; soils; field experiments; horticulture; sugar making; drainage; irrigation.
						Botany; bacteriology; soils; inspection of fertilizers, feeding stuffs, and Paris green; field experiments; horticulture; animal husbandry; diseases of animals; entomology.
21			25	648	18,200	Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; poultry experiments; dairying.
19	5	6	9	314	27,000	Rice experiments.
31	6	7	9	565	17,600	Chemistry; botany; analysis and inspection of foods, fertilizers, concentrated commercial feeding stuffs, and agricultural seeds; calibration of creamery glassware; horticulture; plant pathology; biology; poultry breeding; plant breeding; entomology.
27	13	9	17	425	55,000	Chemistry; fertilizers; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; animal breeding; poultry raising; entomology; dairying.
38	28	25	4	224	17,500	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; pot, cylinder, and field experiments; horticulture; plant breeding; diseases of plants and animals; digestion and feeding experiments; entomology; dairying; effect of electricity on plant growth.
20	5	7	17	432	27,000	Chemistry; analysis and control of fertilizers; bacteriology; field experiments; horticulture; forestry; plant breeding; diseases of plants and animals; feeding and breeding experiments; poultry culture; entomology; stable hygiene.
42	35	30	18	585	7,000	Chemistry; soils; fertilizers; field experiments; horticulture; forestry; diseases of plants and animals; plant and animal breeding; animal nutrition; entomology; dairying; farm management; ventilation; farm statistics.
4						Fertilizers; field experiments; horticulture; biology; plant breeding; animal husbandry; diseases of animals; poultry culture; entomology; dairying; agricultural engineering.
16	8	10	8	134	8,181	Chemistry; soil survey; botany; field experiments; horticulture; diseases of plants and animals; feeding experiments; animal and plant breeding; entomology; dairying.
35	17	21	6	320	21,600	Horticulture; vegetable pathology; entomology; inspection of orchards and nurseries.
14	4		5	334	4,350	Chemistry; meteorology; botany; field experiments; dry farming; horticulture; feeding and breeding experiments; poultry experiments; veterinary science; entomology; dairying; irrigation and drainage.
16	12	11	6	156	14,500	Chemistry; botany; meteorology; soils; field experiments; horticulture; plant breeding; diseases of plants and animals; forestry; feeding and breeding experiments; entomology; dairying; irrigation.
14	6	5	7	322	9,523	Chemistry; meteorology; botany; soils; field experiments; horticulture; plant breeding; forestry; animal feeding and breeding; plant diseases; veterinary science and bacteriology; zoology; entomology; irrigation.
12	6	3	6	495		Chemistry; botany; field experiments; horticulture; plant breeding; breeding experiments; entomology; dairying.
						Chemistry; oyster culture; botany; analyses of fertilizers, foods, commercial feeding stuffs, and insecticides; pot, cylinder, and field experiments; horticulture; plant breeding; forestry; diseases of plants and animals; animal husbandry; poultry experiments; entomology; soil chemistry and bacteriology; soil surveys; irrigation.

TABLE 11.—*General sta*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
New Mexico.....	Agricultural College.	Luther Foster, M. S. A.....	.....	Dec. 14, 1889
New York (State)..	Geneva.....	W H. Jordan, D. Sc., LL. D..	Mar. —, 1882	.....
New York (Cornell).	Ithaca.....	H. J. Webber, Ph. D. ²	— —, 1879	Apr. —, 1888
North Carolina (College).	West Raleigh.....	C. B. Williams, M. S.....	Mar. 12, 1877	Mar. 7, 1887
North Carolina (State).	Raleigh.....	B. W. Kilgore, M. S.....	July 1, 1907	.....
North Dakota.....	Agricultural College.	J. H. Worst, LL. D.....	.....	Mar. —, 1890
Ohio.....	Wooster.....	C. E. Thorne, M. S. A.....	Apr. 25, 1882	Apr. 2, 1888
Oklahoma.....	Stillwater.....	J. A. Craig, B. S. A.....	.....	Dec. 25, 1890
Oregon.....	Corvallis.....	James Withycombe, M. Agr ..	.....	July —, 1888
Pennsylvania.....	State College.....	T. F. Hunt, D. Agr., D. Sc....	.....	June 30, 1887
Rhode Island.....	Kingston.....	H. J. Wheeler, Ph. D.....	.....	July 30, 1888
South Carolina.....	Clemson College....	J. N. Harper, B. S., M. Agr...	.....	Jan. —, 1888
South Dakota.....	Brookings.....	J. W. Wilson, M. S. A.....	.....	Mar. 13, 1887
Tennessee.....	Knoxville.....	H. A. Morgan, B. S. A.....	June 8, 1882	Aug. 4, 1887
Texas.....	College Station.....	H. H. Harrington.....	.....	Jan. 25, 1888
Utah.....	Logan.....	E. D. Ball, Ph. D.....	.....	— —, 1890
Vermont.....	Burlington.....	J. L. Hills, Sc. D.....	Nov. 24, 1886	Feb. 28, 1888

¹ Including substations.² Acting director.

istics, 1910—Continued.

Number on staff. ¹	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1910.		Number of names on mailing list.	Principal lines of work.
			Number.	Pages.		
16	15	.....	5	212	3,200	Chemistry; botany; soils; field experiments; dry farming; horticulture; cactus and guayule plant investigations; feeding experiments; entomology; dairying; irrigation.
28	.....	15	14	688	46,000	Chemistry; bacteriology; meteorology; fertilizers; analysis and control of fertilizers; inspection of feeding stuffs, Paris green, and creamery glassware; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
43	.....	.....	11	364	25,475	Chemistry; soils; field experiments; farm management; horticulture, plant breeding; plant physiology; diseases of plants; feeding and breeding experiments; poultry husbandry; entomology; dairying.
18	9	3	4	207	18,000	Chemistry; soils; field experiments; horticulture; nitrification experiments; diseases of plants and animals; animal husbandry; poultry experiments; dairying; tests of farm machinery.
31	.....	9	12	828	32,000	Chemistry; soils; field experiments; horticulture; diseases of animals; feeding experiments; entomology; fertilizer experiments and analyses; inspection of foods and stock feeds; cooperative demonstration work with farmers; farmers' institutes.
38	21	11	34	1,036	19,500	Chemistry; soils; botany; field experiments; plant breeding; horticulture; forestry; diseases of plants and animals; analysis of foods and spraying materials; inspection and analysis of paints, drugs, proprietary products, and feeding stuffs; feeding and breeding experiments; poultry experiments; milling and chemical tests of wheat; drainage; farm engineering.
47	.....	32	21	811	45,000	Chemistry; soils; field experiments; botany; horticulture; plant breeding; forestry; diseases of plants; feeding experiments; entomology; nutrition; farm management.
13	13	14	5	150	18,868	Chemistry; field experiments; horticulture; forestry; botany; bacteriology; animal husbandry; dairying; veterinary science; entomology.
34	11	11	8	114	11,000	Chemistry; bacteriology; soils; fertilizers; field crops; horticulture; plant breeding and selection; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
43	25	13	10	485	42,000	Chemistry; meteorology; fertilizers; horticulture; forestry; plant diseases; field experiments; feeding experiments; dairying; poultry experiments.
15	4	4	9	353	11,000	Chemistry; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments; horticulture; poultry and pigeon breeding; poultry husbandry.
14	.....	6	8	93	14,500	Chemistry; soils; botany; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; veterinary science; entomology; dairying.
24	13	5	8	200	22,000	Chemistry; botany; horticulture; field experiments; plant breeding; diseases of plants and animals; animal husbandry; dairying.
22	9	8	4	73	12,602	Chemistry; soil investigations; inspection of fertilizers; field experiments; horticulture; plant breeding; seeds; weeds; diseases of plants and animals; feeding experiments; entomology; dairying; apiculture.
27	3	6	6	202	27,000	Chemistry; examination and comparison of commercial feeding stuffs and fertilizers; soils; field experiments; horticulture; plant breeding; feeding experiments; diseases of plants and animals and selection; entomology.
22	7	8	4	156	9,500	Chemistry of soils; field experiments; horticulture; diseases of plants and animals; breeding and feeding experiments; poultry experiments; entomology; irrigation and drainage; arid farming.
16	7	11	14	780	14,450	Chemistry; botany; bacteriology; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; state nursery for forest-tree seedlings; horticulture; diseases of plants; feeding and breeding experiments; dairying.

TABLE 11.—*General sta*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Virginia	Blacksburg	S. W. Fletcher, Ph. D. ....	.....	Oct. 16, 1888
Do	Norfolk	T. C. Johnson, B. S., Agr., A. M.	Feb. —, 1907	.....
Washington	Pullman	R. W. Thatcher, B. S., M. A. ....	.....	— —, 1891
West Virginia	Morgantown	J. H. Stewart, M. A. ....	.....	— —, 1887
Wisconsin	Madison	H. L. Russell, Ph. D.	— —, 1883	— —, 1887
Wyoming	Laramie	J. D. Towar, M. S. ....	.....	Mar. 1, 1891
Total .....	.....	.....	.....	.....

istics, 1910—Continued.

Number on staff. ¹	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1910.		Number of names on mailing list.	Principal lines of work.
			Number.	Pages.		
16	7	4	7	298	23,000	Chemistry; biology; field experiments; horticulture; plant breeding; soil bacteriology; mycology; breeding and feeding experiments; diseases of animals; dairying.
5	-----	1	3	56	6,500	Field experiments; plant breeding; plant diseases; entomology.
27	12	8	25	411	15,200	Chemistry; botany; bacteriology; soils; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; veterinary science; entomology; irrigation; dry farming; clearing logged-off lands.
15	1	5	5	152	9,351	Chemistry; effect of pressure in the preservation of fruits, vegetables, and milk; artificial fixation of atmospheric nitrogen; analysis and control of fertilizers; soils; field experiments; horticulture; diseases of plants and animals; inspection of orchards and nurseries; feeding and breeding experiments; poultry experiments; entomology; dairying.
70	55	10	42	983	20,000	Chemistry; bacteriology; soils; field experiments; agronomy; tobacco and cranberry culture; horticulture; plant breeding; plant pathology; breeding and feeding experiments; poultry experiments; veterinary science, entomology; dairying; irrigation and drainage; agricultural engineering; agricultural economics; home economics; extension.
13	6	7	4	112	4,500	Chemistry; mycology; botany; meteorology; soils; range improvement; fertilizers; field experiments; plant selection; poisonous plant investigations; food analysis; breeding and feeding experiments; wool investigation; veterinary science; irrigation; effects of alkali on structural and other material.
1,403	552	510	583	20,216	952,901	

¹ Including substations.

TABLE 12.—*Revenue and ad*

Station.	Federal.		State.	Individuals and communities.	Fees.	Farm products.
	Hatch fund.	Adams fund.				
1 Alabama (College)	\$15,000.00	\$13,000.00				\$965.60
2 Alabama (Canebrake)			\$2,500.00			
3 Alabama (Tuskegee)			1,500.00			
4 Arizona	15,000.00	13,000.00	(3)	\$89.00		1,772.55
5 Arkansas	15,000.00	13,000.00	20,942.31		\$31.50	19,810.98
6 California	15,000.00	13,000.00	175,480.22		17,007.40	41,958.35
7 Colorado	15,000.00	13,000.00	52,500.00			
8 Connecticut (State)	7,500.00	6,500.00	18,500.00	8,817.18	10,300.00	160.81
9 Connecticut (Storrs)	7,500.00	6,500.00	1,950.00			
10 Delaware	15,000.00	13,000.00				608.42
11 Florida	15,000.00	13,000.00			85.00	1,058.79
12 Georgia	15,000.00	13,000.00	710.10			5,760.51
13 Idaho	15,000.00	13,000.00				4,098.07
14 Illinois	15,000.00	13,000.00	138,000.00			14,546.81
15 Indiana	15,000.00	13,000.00	75,000.00		22,837.21	
16 Iowa	15,000.00	13,000.00	40,000.00		15.00	10,973.76
17 Kansas	15,000.00	13,000.00	457,400.00		7,499.53	7,152.02
18 Kentucky	15,000.00	13,000.00	15,456.77		41,581.28	11,361.75
19 Louisiana	15,000.00	13,000.00	10,000.00		4,500.00	2,918.87
20 Maine	15,000.00	13,000.00	14,500.00		10,500.00	
21 Maryland	15,000.00	13,000.00	11,500.00			8,189.46
22 Massachusetts	15,000.00	13,000.00	13,500.00	544.17	5,970.00	3,208.73
23 Michigan	15,000.00	13,000.00	4,122.07		4,080.00	
24 Minnesota	15,000.00	13,000.00	40,185.87			6,212.19
25 Mississippi	15,000.00	13,000.00	616,425.00		90.00	428,799.57
26 Missouri (College)	15,000.00	13,000.00			710,580.20	8,052.30
27 Missouri (Fruit)			(9)			
28 Montana	15,000.00	13,000.00	32,990.48	7,011.26		6,384.34
29 Nebraska	15,000.00	13,000.00	1042,494.93			
30 Nevada	15,000.00	13,000.00				2,945.23
31 New Hampshire	15,000.00	13,000.00				
32 New Jersey (State)			39,000.00			
33 New Jersey (College)	15,000.00	13,000.00				
34 New Mexico	15,000.00	13,000.00			1,496.07	2,208.19
35 New York (State)	1,500.00	1,300.00	98,243.85			
36 New York (Cornell)	13,500.00	11,700.00				
37 North Carolina (College)	15,000.00	13,000.00	1,400.00			4,879.56
38 North Carolina (State)			70,000.00			
39 North Dakota	15,000.00	13,000.00	16,281.45			
40 Ohio	15,000.00	13,000.00	166,295.00			14,775.62
41 Oklahoma	15,000.00	13,000.00				
42 Oregon	15,000.00	13,000.00	16,100.00			3,246.47
43 Pennsylvania	15,000.00	13,000.00	5,000.00		12,616.00	13,288.05
44 Rhode Island	15,000.00	13,000.00		2.00		
45 South Carolina	15,000.00	13,000.00				5,400.52
46 South Dakota	15,000.00	13,000.00	10,000.00			3,015.35
47 Tennessee	15,000.00	13,000.00	610,000.00			8,101.81
48 Texas	15,000.00	13,000.00	632,000.00			818.90
49 Utah	15,000.00	13,000.00	13,554.94			3,667.81
50 Vermont	15,000.00	13,000.00	4,441.07		3,145.09	6,187.13
51 Virginia	15,000.00	13,000.00	5,000.00	5.00		2,706.75
52 Virginia (Norfolk)			10,000.00			
53 Washington	15,000.00	13,000.00	1126,896.00			13,224.87
54 West Virginia	15,000.00	13,000.00	10,000.00		13,506.84	6,500.89
55 Wisconsin	15,000.00	13,000.00	18,500.00		9,296.84	
56 Wyoming	15,000.00	13,000.00				5,541.79
Total	720,000.00	624,000.00	1,320,370.06	16,468.61	175,137.96	277,502.82

¹ Including all balances.² Biennial appropriation for 1909-1911 reported last year.³ Including farm implements.⁴ Including substations.⁵ Highmore farm purchased by State for use of station.⁶ For substations.

ditions to equipment, 1910.

Miscellaneous.	Total.	Additions to equipment.						Total.	
		Buildings.	Library.	Apparatus.	Farm implements.	Live stock.	Miscellaneous. ¹		
\$763.83	\$29,729.43	\$1,155.00	\$500.00	\$1,550.00	\$200.00	\$465.00	\$450.00	\$4,320.00	1
-----	2,500.00	98.62	22.50	-----	286.00	465.00	-----	872.12	2
-----	1,500.00	-----	25.00	-----	119.00	-----	-----	144.00	3
14,547.03	44,408.58	-----	108.43	204.95	412.54	306.00	-----	1,031.92	4
24,585.62	93,370.41	1,055.68	59.10	621.04	1,111.03	635.98	1,977.88	5,460.71	5
31,632.13	294,078.10	72,747.27	1,472.90	3,966.33	6,738.63	7,557.20	7,340.04	99,822.37	6
22,578.84	103,078.84	3,864.42	173.67	3,464.56	836.41	-----	1,127.12	9,466.18	7
594.42	52,372.41	-----	622.06	9.45	99.22	-----	426.75	1,157.48	8
701.84	16,651.84	210.09	173.49	102.28	48.35	64.50	-----	598.71	9
-----	28,608.42	10,000.00	296.11	915.07	330.18	870.46	1,460.17	13,871.99	10
31.16	29,174.95	40,877.00	417.81	9,178.68	131.56	548.50	759.08	51,912.63	11
1,830.17	36,300.78	912.20	188.58	231.05	814.04	379.30	-----	2,525.17	12
257.10	32,355.17	861.48	13.91	3401.86	-----	126.90	-----	1,404.15	13
21,393.11	201,939.92	4,500.00	200.10	861.20	2,317.53	1,037.77	-----	8,916.60	14
53,411.17	179,248.38	17,597.92	732.30	574.29	820.41	10,301.76	136,863.33	166,890.01	15
2,408.66	81,397.42	1,079.52	-----	1,672.54	503.05	2,905.50	746.26	6,906.87	16
11,258.54	91,310.09	1,772.53	83.59	995.01	1,856.94	5,329.09	2,146.64	12,183.80	17
8,865.73	105,265.53	777.81	698.63	1,704.87	1,478.85	535.00	806.90	6,002.06	18
1,482.62	46,901.49	8,407.91	605.30	1,381.79	2,217.67	1,766.04	-----	14,378.71	19
2,566.55	55,566.55	346.34	874.66	588.86	541.27	635.22	10,000.00	12,986.35	20
116.91	47,806.37	1,655.66	539.41	223.05	431.60	980.00	418.77	4,248.49	21
11,926.34	63,149.24	403.23	242.35	2,034.29	26.70	128.38	-----	2,834.95	22
1,979.54	40,181.61	12,000.00	578.01	2,972.73	883.66	-----	-----	16,434.40	23
-----	74,398.06	2,300.00	2,509.56	2,290.40	1,569.24	4,930.95	3,202.13	16,802.28	24
43,577.26	76,891.83	800.00	250.00	280.00	-----	4,045.00	-----	5,375.00	25
3,212.21	46,844.71	4,433.28	-----	927.07	382.35	2,095.28	241.67	8,079.65	26
-----	74,386.08	19,415.10	336.12	1,079.32	2,412.89	2,266.93	53,115.05	78,625.41	27
30,857.48	101,352.41	23,000.00	-----	1,592.00	800.00	4,000.00	-----	29,392.00	28
618.01	31,563.24	1,329.10	10.28	812.92	-----	250.00	92.50	2,494.80	29
3,873.37	31,873.37	1,583.80	642.72	465.31	48.40	41.00	396.30	3,177.53	31
-----	39,000.00	-----	55.60	316.64	998.84	-----	166.96	1,538.04	32
-----	28,000.00	519.59	1,887.20	749.15	757.16	250.00	-----	4,163.10	33
-----	31,704.26	1,940.53	1,326.80	772.91	410.75	330.00	-----	4,780.99	34
3,085.98	104,129.83	1,136.14	223.37	789.33	-----	-----	-----	2,148.84	35
-----	25,200.00	199.56	589.70	-----	-----	-----	-----	789.26	36
-----	34,279.56	800.00	180.79	111.50	806.88	650.00	-----	2,549.17	37
-----	70,000.00	3,600.00	200.00	250.00	400.00	2,000.00	-----	6,450.00	38
16,754.41	61,035.86	128,831.84	2,090.19	5,840.84	1,832.10	6,148.38	4,036.49	148,779.84	39
96,510.98	305,581.60	4,850.86	855.13	3,206.70	753.89	5,046.40	-----	14,712.98	40
3,991.22	31,991.22	732.79	64.24	324.31	306.66	3,209.42	-----	4,637.42	41
3,508.08	50,854.55	-----	69.81	179.28	162.10	27.00	3,362.12	3,809.31	42
4,871.68	63,775.73	751.55	472.07	605.64	524.45	3,237.71	-----	5,591.42	43
7,666.76	35,668.76	2,613.38	745.30	124.17	372.88	436.85	72.18	4,364.76	44
3,209.01	36,609.63	642.45	265.21	163.81	717.22	2,503.71	-----	4,292.40	45
3,449.95	44,465.30	11,000.00	250.00	1,002.00	920.00	150.00	-----	13,569.00	46
-----	46,101.81	26,806.62	504.71	1,242.51	2,789.23	1,670.00	482.53	33,495.60	47
956.82	61,775.72	35,651.16	383.17	1,333.35	302.85	338.60	2,069.37	40,078.50	48
471.40	45,694.15	137.67	135.26	989.67	467.94	2,545.00	319.20	4,594.74	49
-----	41,773.29	455.05	393.54	881.04	-----	322.00	-----	2,051.43	50
3,520.03	39,231.78	205.00	407.50	339.50	245.80	1,231.65	80.00	2,509.45	51
-----	10,000.00	1,500.00	200.00	100.00	260.00	285.00	225.00	2,570.00	52
-----	68,120.87	-----	237.87	701.20	312.50	100.00	514.16	1,865.73	53
77.38	58,085.11	1,206.99	1,056.49	2,612.92	153.99	8.00	15.00	5,053.39	54
-----	55,796.84	14,619.77	872.62	2,055.27	1,536.74	1,619.66	2,843.76	23,547.82	55
1,077.46	34,619.25	8,000.00	100.00	800.00	600.00	3,000.00	-----	12,500.00	56
404,220.80	3,537,700.25	331,974.25	79,117.14	47,505.12	62,950.11	35,124.59	382,079.32	938,750.53	

⁷ Less deficit of \$3,556.38, June 30, 1909.⁸ Less deficit of \$2,422.41, June 30, 1909.⁹ State appropriation for biennium ended December 1, 1910, reported last year.¹⁰ Including \$24,994.93 of the biennial appropriation for the North Platte Substation, and \$17,500 as estimated amount of State appropriation spent for experimental purposes at Lincoln station.¹¹ One-half of State appropriation for biennium ending March 31, 1911.

TABLE 13.—*Expenditures from United States appropriation of Mar. 2, 1887,*

	Stations.	Amount of appropriation.	Classified expenditures.					
			Salaries.	Labor.	Publications.	Postage and stationery.	Freight and express.	Heat, light, and water.
1	Alabama.....	\$15,000.00	\$7,503.73	\$1,293.23	\$1,274.96	\$338.16	\$189.57	\$604.03
2	Arizona.....	15,000.00	7,845.95	3,072.42	133.27	593.93	277.28	201.07
3	Arkansas.....	15,000.00	6,947.55	1,715.41	483.50	290.93	621.82	649.73
4	California.....	15,000.00	7,676.26	4,013.98	252.09	625.13	120.44	160.88
5	Colorado.....	15,000.00	7,749.26	278.78	1,727.98	543.00	171.02	77.14
6	Connecticut (State).....	7,500.00	7,500.00					
7	Connecticut (Storrs).....	7,500.00	5,943.99	965.14		59.86	7.33	111.37
8	Delaware.....	15,000.00	6,165.87	3,902.15	307.82	221.45	119.08	191.73
9	Florida.....	15,000.00	7,347.96	2,278.39	1,124.53	508.26	89.98	53.41
10	Georgia.....	15,000.00	7,458.37	3,152.38	610.56	264.20	121.90	221.82
11	Idaho.....	15,000.00	8,018.98	3,623.19	33.15	172.61	82.39	673.88
12	Illinois.....	15,000.00	8,481.09	3,034.62	1,325.55	585.61	72.19	163.15
13	Indiana.....	15,000.00	6,866.64	756.08	3,648.58	349.32	19.92	482.40
14	Iowa.....	15,000.00	6,920.00	1,770.81	1,464.67	415.94	91.60	49.36
15	Kansas.....	15,000.00	8,011.34	2,453.76	5.82	704.42	234.94	325.40
16	Kentucky.....	15,000.00	9,045.00	2,657.32	792.62	352.85	136.14	234.06
17	Louisiana.....	15,000.00	13,697.85	336.80	304.70	24.00	5.77	16.59
18	Maine.....	15,000.00	6,532.51	1,282.21	169.17	447.32	402.17	256.12
19	Maryland.....	15,000.00	10,947.28	1,127.05	773.05	184.84	264.68	137.76
20	Massachusetts.....	15,000.00	13,184.81	264.74	49.75	95.12		7.43
21	Michigan.....	15,000.00	7,473.17	2,907.62	213.31	256.77	214.22	62.43
22	Minnesota.....	15,000.00	8,849.87		76.50	31.73		2,331.98
23	Mississippi.....	15,000.00	7,281.35	3,312.54	409.80	364.62	202.11	294.97
24	Missouri.....	15,000.00	6,488.66	3,930.65		130.83	77.20	32.28
25	Montana.....	15,000.00	8,063.35	2,575.50	369.48	756.38	196.71	534.46
26	Nebraska.....	15,000.00	9,467.57	262.38	2,367.22	691.30	56.40	
27	Nevada.....	15,000.00	7,221.45	3,638.75	1,348.61	230.97	304.63	129.00
28	New Hampshire.....	15,000.00	6,969.81	1,719.35	1,838.04	468.31	192.68	1,085.45
29	New Jersey.....	15,000.00	7,133.33	1,371.67	1,226.92	576.32	77.84	392.34
30	New Mexico.....	15,000.00	7,568.28	2,465.91	776.24	261.95	257.28	118.98
31	New York (State).....	1,500.00	756.68	729.07				
32	New York (Cornell).....	13,500.00	7,598.64	1,471.92	1,642.89	666.71	67.44	225.59
33	North Carolina.....	15,000.00	9,499.26	2,851.98		308.29	176.65	94.11
34	North Dakota.....	15,000.00	9,353.93	4,215.83	563.63	23.92		
35	Ohio.....	15,000.00	13,857.50		260.00	100.17		
36	Oklahoma.....	15,000.00	9,981.28	1,672.11	747.66	471.92	142.43	157.89
37	Oregon.....	15,000.00	10,123.16	2,064.91	130.90	208.72	35.72	31.75
38	Pennsylvania.....	15,000.00	6,031.28	3,589.66	1,300.78	848.32	189.21	6.35
39	Rhode Island.....	15,000.00	8,384.97	1,973.35	149.70	279.14	117.89	421.43
40	South Carolina.....	15,000.00	8,375.00	2,139.57	1,031.51	142.70	197.57	53.32
41	South Dakota.....	15,000.00	7,205.25	2,452.78	2,054.55	249.96	96.93	
42	Tennessee.....	15,000.00	8,314.99	2,691.69	539.04	383.71	112.42	313.13
43	Texas.....	15,000.00	6,641.39	1,879.91	1,596.78	677.98	252.87	37.93
44	Utah.....	15,000.00	8,519.88	3,134.87	124.61	165.10	4.85	52.80
45	Vermont.....	15,000.00	8,126.18	2,637.44	203.65	811.32	76.09	528.78
46	Virginia.....	15,000.00	6,882.29	1,961.89	1,778.56	578.85	280.44	
47	Washington.....	15,000.00	6,537.73	2,423.16	1,421.55	831.83	216.33	572.90
48	West Virginia.....	15,000.00	11,365.89	813.90		280.86	234.37	133.00
49	Wisconsin.....	15,000.00	6,570.00	2,175.00		32.52	2.50	
50	Wyoming.....	15,000.00	8,070.00	1,672.54	376.52	268.21	316.74	592.52
Total.....		720,000.00	402,556.68	102,814.41	37,030.22	17,856.36	7,127.74	12,159.49
								7,510.02

for the agricultural experiment stations for the year ended June 30, 1910.

Classified expenditures.											
Seeds, plants, and sundry supplies.	Fertiliz- ers.	Feeding stuffs.	Li- brary.	Tools, imple- ments, and ma- chinery.	Furni- ture and fix- tures.	Scien- tific appa- ratus.	Live stock.	Travel- ing ex- penses.	Con- tin- gent ex- penses.	Build- ings and land.	Bal- ances.
\$457.97	\$507.67	-----	\$556.14	\$145.98	\$19.80	\$184.72	\$165.00	\$54.46	\$15.00	\$579.70	\$800.00
537.69	132.09	883.85	102.54	223.33	378.82	55.64	306.00	498.99	-----	456.69	-----
1,137.21	1.37	791.10	20.30	787.03	480.00	-----	-----	256.19	15.00	748.02	-----
323.47	128.75	47.30	9.16	42.42	406.35	7.50	-----	643.94	93.26	125.20	-----
93.68	-----	96.00	117.09	304.32	1,065.86	845.05	-----	921.40	15.00	750.00	244.42
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
35.81	-----	49.66	71.08	6.05	40.79	-----	-----	24.00	15.00	85.38	-----
1,034.64	473.06	616.73	228.32	281.18	49.05	42.30	647.00	157.72	15.00	348.57	-----
337.21	117.77	951.30	308.56	115.71	72.64	1.80	542.50	463.72	15.00	665.49	-----
353.37	105.64	1,167.07	3.00	814.08	-----	-----	65.50	37.00	15.00	610.11	-----
278.73	-----	553.83	23.53	585.74	13.25	37.58	12.50	261.86	15.00	371.76	175.87
177.74	13.91	30.77	200.10	218.49	74.31	13.20	117.77	80.25	15.00	-----	-----
680.87	-----	46.20	294.16	62.75	476.80	35.00	-----	156.45	-----	600.59	-----
622.87	-----	996.24	-----	163.10	109.76	481.00	1,169.49	-----	-----	535.64	-----
530.38	68.66	597.58	-----	565.57	1,061.80	152.66	71.00	192.22	15.00	69.45	-----
380.46	-----	-----	583.78	38.00	201.55	100.00	-----	150.76	15.09	297.88	-----
138.97	-----	169.96	3.99	69.67	-----	-----	27.50	12.35	89.13	101.22	-----
526.20	358.22	1,096.60	616.94	535.82	806.60	445.97	616.68	417.73	115.25	336.34	-----
91.98	-----	524.61	120.85	106.81	28.25	-----	650.00	-----	15.00	-----	-----
250.19	348.61	406.48	47.44	-----	117.00	123.75	48.00	56.68	-----	-----	-----
870.84	433.84	-----	570.94	397.21	179.10	200.77	-----	504.00	15.00	-----	-----
358.30	-----	2,297.90	-----	314.99	138.00	89.48	135.00	173.18	-----	158.15	-----
655.34	28.10	608.32	48.91	601.63	102.80	-----	286.45	477.17	15.00	242.41	-----
523.54	-----	2,076.14	-----	258.85	70.00	16.38	1,236.08	79.13	15.00	-----	-----
526.73	-----	415.10	322.43	201.65	215.84	246.15	129.75	165.10	15.00	113.85	-----
215.76	142.62	148.53	-----	82.35	265.40	156.42	690.84	363.45	15.00	-----	-----
633.09	56.75	123.00	-----	-----	-----	65.10	250.00	169.15	55.00	741.58	-----
359.88	387.40	166.17	496.71	14.15	205.05	63.97	-----	269.71	15.00	726.24	-----
123.44	-----	240.00	1,788.00	109.00	348.50	394.28	250.00	239.07	15.00	390.14	-----
532.68	247.95	1,130.72	-----	194.24	-----	-----	336.00	275.70	380.00	356.97	-----
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
518.44	-----	2.00	188.99	-----	387.18	277.55	-----	233.24	-----	219.41	-----
447.97	-----	545.17	58.29	445.24	227.54	-----	-----	330.50	15.00	-----	-----
75.62	-----	35.29	-----	64.50	-----	-----	-----	-----	15.50	-----	552.28
-----	-----	-----	-----	-----	-----	-----	-----	17.33	15.00	750.00	-----
341.15	-----	385.14	36.43	186.21	40.60	60.48	40.34	199.62	15.00	229.89	-----
318.30	-----	509.96	35.90	2.15	-----	-----	27.00	19.10	15.00	2.25	1,475.18
463.25	131.00	372.27	147.44	117.65	246.39	21.37	650.00	171.40	15.00	698.63	-----
252.56	195.65	748.39	581.76	447.01	34.18	23.06	403.25	454.53	15.00	384.29	-----
385.23	446.32	831.30	98.51	285.26	213.76	-----	121.00	109.25	15.00	414.48	-----
267.58	-----	133.10	65.13	66.32	161.25	387.55	1,122.09	-----	15.00	267.43	-----
206.11	261.29	830.65	264.42	491.95	158.68	5.00	100.00	82.08	15.00	-----	-----
551.60	13.93	495.07	296.81	295.85	970.04	12.22	338.60	455.07	15.00	451.11	-----
181.90	40.00	634.78	49.30	279.87	226.75	-----	1,248.50	202.15	24.50	62.49	-----
402.61	173.27	15.75	393.34	44.53	232.96	290.86	140.00	346.37	15.00	347.84	-----
496.72	78.77	-----	348.57	65.82	18.37	144.75	285.00	604.57	41.50	205.03	1,210.99
519.19	-----	299.17	229.80	171.00	338.40	126.19	-----	1,049.12	85.00	-----	-----
45.98	-----	744.05	250.06	-----	45.80	381.25	-----	428.00	15.00	15.70	-----
350.20	-----	2,921.22	209.17	364.59	51.00	625.08	-----	259.93	15.00	698.74	-----
421.96	-----	1,499.11	10.00	313.81	23.50	94.65	384.90	303.33	15.00	351.85	-----
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
19,056.01	4,892.64	26,435.58	9,792.89	10,881.88	10,243.72	6,208.73	12,613.74	12,456.99	1,393.64	14,510.52	4,458.74

TABLE 14.—*Expenditures from United States appropriation of March 16, 1906,*

Station.	Amount of appropriation.	Classified expenditures.						
		Salaries.	Labor.	Postage and stationery.	Freight and express.	Heat, light, and water.	Chemical supplies.	Seeds, plants, and sundry supplies.
1 Alabama.....	\$13,000.00	\$7,837.57	\$805.75	\$37.90	\$182.05	\$28.60	\$118.77	\$761.49
2 Arizona.....	13,000.00	11,283.91	461.30	11.06	118.76	.....	190.57	87.94
3 Arkansas.....	13,000.00	9,664.86	270.46	36.45	49.54	97.91	470.93	263.67
4 California.....	13,000.00	4,552.25	3,433.94	29.38	86.37	74.38	761.65	495.63
5 Colorado.....	13,000.00	7,577.83	129.15	46.33	93.44	86.24	647.81	27.91
6 Connecticut (State).....	6,500.00	3,752.46	1,590.69	14.18	49.46	.....	702.92	31.70
7 Connecticut (Storrs).....	6,500.00	4,332.49	649.53	60.18	13.52	232.50	270.53	603.86
8 Delaware.....	13,000.00	8,145.91	509.89	14.21	74.91	184.82	1,248.02	230.52
9 Florida.....	13,000.00	9,130.63	130.97	4.75	279.70	138.27	661.39	421.87
10 Georgia.....	13,000.00	7,836.61	1,569.34	146.10	235.28	134.11	59.60	520.14
11 Idaho.....	13,000.00	5,837.25	2,427.35	122.09	231.28	219.41	219.47	596.07
12 Illinois.....	13,000.00	8,772.25	2,738.59	9.16	24.55	.....	12.46	223.68
13 Indiana.....	13,000.00	9,071.64	645.75	55.30	3.98	.....	354.74	111.77
14 Iowa.....	13,000.00	8,080.75	1,963.45	16.60	29.48	143.86	718.64	237.72
15 Kansas.....	13,000.00	5,173.40	3,305.52	38.35	150.20	7.92	960.04	495.51
16 Kentucky.....	13,000.00	11,266.00	.....	.....	.....	.....	347.15	71.37
17 Louisiana.....	13,000.00	9,677.34	334.29	3.00	12.25	403.73	560.52	46.51
18 Maine.....	13,000.00	11,666.19	160.00	.....	14.42	.....	.....	436.47
19 Maryland.....	13,000.00	9,026.29	3.87	54.05	.....	243.88	329.73	66.36
20 Massachusetts.....	13,000.00	9,918.15	817.05	19.00	13.35	149.47	114.41	496.08
21 Michigan.....	13,000.00	6,508.25	1,091.00	21.64	184.55	.....	2,088.90	1,507.09
22 Minnesota.....	13,000.00	9,614.28	.....	.....	34.39	77.10	236.67	69.77
23 Mississippi.....	13,000.00	3,922.54	3,364.48	4.57	148.42	137.62	183.66	491.91
24 Missouri.....	13,000.00	3,691.79	3,379.34	.....	.....	33.12	1,640.18	518.95
25 Montana.....	13,000.00	8,185.66	2,291.44	16.93	79.73	.....	236.75	337.87
26 Nebraska.....	13,000.00	8,593.52	1,162.78	65.74	54.47	.....	325.06	394.42
27 Nevada.....	13,000.00	8,204.82	276.87	15.82	287.01	28.05	1,050.30	417.75
28 New Hampshire.....	13,000.00	7,479.64	2,435.08	66.65	85.02	.....	253.48	335.47
29 New Jersey.....	13,000.00	8,610.00	1,145.73	1.71	3.34	56.86	506.63	544.34
30 New Mexico.....	13,000.00	7,741.68	1,508.67	95.26	374.79	282.42	293.60	250.86
31 New York (State).....	1,300.00	1,300.00	.....	.....	.....	.....	.....	.....
32 New York (Cornell).....	11,700.00	8,864.98	1,087.08	49.17	48.60	.....	437.45	329.76
33 North Carolina.....	13,000.00	7,722.40	1,534.75	243.81	133.85	241.97	432.19	459.79
34 North Dakota.....	13,000.00	7,974.84	1,247.98	.....	.....	.....	92.36	444.74
35 Ohio.....	13,000.00	9,765.00	367.32	.....	.....	.....	717.50	15.29
36 Oklahoma.....	13,000.00	5,367.50	1,771.30	3.40	125.48	107.65	91.23	398.98
37 Oregon.....	13,000.00	6,849.56	2,223.85	101.74	82.24	190.59	902.20	521.40
38 Pennsylvania.....	13,000.00	7,236.66	1,359.50	40.70	151.65	.....	1,501.48	550.45
39 Rhode Island.....	13,000.00	9,220.69	1,587.81	74.79	51.50	493.81	110.88	352.71
40 South Carolina.....	13,000.00	7,175.00	2,889.66	142.84	111.52	51.58	261.23	410.52
41 South Dakota.....	13,000.00	7,244.71	2,502.25	44.40	303.95	120.23	681.46	814.56
42 Tennessee.....	13,000.00	9,383.29	584.83	16.48	271.46	207.83	363.18	196.53
43 Texas.....	13,000.00	7,073.32	1,414.47	61.55	169.00	105.05	1,200.31	372.66
44 Utah.....	13,000.00	6,737.38	2,685.48	69.35	38.57	242.89	516.35	308.23
45 Vermont.....	13,000.00	5,472.03	3,104.84	66.09	56.71	64.08	337.91	126.32
46 Virginia.....	13,000.00	8,176.69	1,123.43	115.17	135.23	131.77	223.02	933.73
47 Washington.....	13,000.00	8,995.60	1,600.07	33.92	93.05	16.45	592.42	288.85
48 West Virginia.....	13,000.00	7,889.58	1,068.90	1.79	.....	.....	56.25	11.00
49 Wisconsin.....	13,000.00	7,600.00	889.00	.....	.....	.....	1,015.07	1,418.50
50 Wyoming.....	13,000.00	7,489.16	268.76	63.55	324.02	152.56	887.35	248.38
Total.....	624,000.00	352,695.35	67,913.56	2,135.16	5,011.09	4,886.63	25,982.42	19,297.10

for the agricultural experiment stations for the year ended June 30, 1910.

Classified expenditures.

Fertilizers.	Feeding stuffs.	Li-brary.	Tools, imple-ments, and ma-chinery.	Furni-ture and fixtures.	Scientific appa-ratus.	Live stock.	Travel-ing ex-penses.	Conting-ent ex-penses.	Build-ings and land.	Bal-ances.	
\$84.27	\$366.20	\$14.90	\$90.27	\$103.65	\$1,156.31	\$252.00	\$183.25		\$577.02	\$400.00	1
		5.89	182.98		141.31		258.40		257.88		2
	431.76	28.80	174.00	27.00	621.04	235.98	359.94		267.66		3
60.15	8.81	1.20	76.00	158.60	909.69		1,707.45		644.50		4
		56.08	2.70	61.20	2,166.95		437.07		500.00	1,117.29	5
88.16	.50						202.43		7.50		6
31.75	19.00	85.98	24.67	3.85	102.28		44.34		25.52		7
114.30	5.00	67.79	516.17	40.00	872.77	223.46	108.02		644.21		8
51.32		91.56	33.30	14.04	895.51		496.73		649.96		9
	1,135.72	180.58			231.05	216.77	114.91		619.79		10
		55.00	216.64	357.50	1,089.04		328.90		24.29	1,275.71	11
	745.52		1.25	403.50		50.00	19.01				12
	175.10	52.18	115.75		273.90	1,036.50	466.79		636.60		13
	1,208.12		88.58		471.25		41.55				14
	355.92	43.75	342.66	352.16	276.08	1,262.09	108.57		127.83		15
					1,315.48						16
	29.65	5.33	38.78	57.00	1,346.24	8.95	421.30	\$29.21	25.90		17
	24.19	191.32		85.63	42.89	5.00	373.89				18
	1,829.65	345.18	93.20	47.80	196.60		122.10		641.29		19
95.01		6.45		328.50	892.02		105.51		45.00		20
3.93	276.60	16.09	86.12	18.88	724.28	349.99	122.68				21
	1,284.41		57.79	209.00	1,245.63	51.00			117.75	2.01	22
	1,009.45	65.82	397.47	145.83	355.08	1,832.34	295.84		645.07		23
96.82	2,290.12		198.05	113.72	467.32	420.50	150.09				24
	497.49	32.80	91.25	49.65	724.25		455.18				25
	106.53		393.89		1,436.82	268.40	200.37				26
	42.40	10.28		92.50	747.82		129.50		587.52	1,109.36	27
147.48	766.55	130.28	7.00	73.13	362.78	40.00	176.62		640.82		28
160.00	240.00	99.20	517.31	152.50	354.87		36.84		129.45	441.22	29
	42.06	62.22	943.02	60.16	770.83		3.60		570.83		30
											31
		15.47		317.35	354.20		88.62		107.32		32
547.11	549.62	119.50	324.03	239.50	111.50	227.95	81.44	2.00	28.59		33
14.25	795.68		299.51	78.00	1,572.64	480.00					34
		66.43			1,144.32	193.00	81.78		649.36		35
	500.30		120.45	81.46	263.83	2,951.08	206.39		650.00	360.95	36
30	757.55	10.96	6.80		179.28		898.53		275.00		37
807.07		224.54	63.00	31.87	399.89		443.89		189.30		38
148.82	617.59	78.65	34.43	38.00	101.11	31.60	44.28		13.33		39
245.52	901.96	14.75	211.76		158.81	82.78	98.70	21.70	121.67	100.00	40
18.40	345.20		78.02	43.50	578.93	150.00			74.39		41
		240.29	1.10	323.85	1,237.51	20.00	152.30		1.35		42
108.05	298.20	86.36	7.00	83.65	1,321.13	247.00	252.20		200.05		43
	239.86		188.07	92.45	761.83	66.51	752.68		300.35		44
	2,781.14		44.20	20.50	590.18	182.00	46.79		107.21		45
35.93	823.97	52.95	21.33		87.21	923.02	168.78		7.77	40.00	46
		8.07	141.50	15.70	575.01	100.00	25.20		514.16		47
	1,940.65				2,031.83						48
	1,596.50			4.25	281.00	146.13	49.55				49
	2,024.71	4.48	29.38	103.94	1,034.01	296.00	61.95		11.75		50
2,858.64	27,063.68	2,571.13	6,259.43	4,429.82	32,974.31	12,350.05	11,033.99	52.91	11,638.19	4,846.54	

TABLE 15.—Disbursements from the United States Treasury to the States and Territories for agricultural experiment stations under the acts of Congress approved Mar. 2, 1887, and Mar. 16, 1906.

State or Territory.	Hatch Act.		Adams Act.	
	1888-1909	1910	1906-1909	1910
Alabama.....	\$329,999.34	\$14,200.00	\$29,019.89	\$12,600.00
Arizona.....	294,803.15	15,000.00	32,000.00	13,000.00
Arkansas.....	328,163.12	15,000.00	32,000.00	13,000.00
California.....	330,000.00	15,000.00	31,926.84	13,000.00
Colorado.....	329,963.24	15,000.00	31,756.22	13,000.00
Connecticut.....	330,000.00	15,000.00	32,000.00	13,000.00
Dakota Territory.....	56,250.00			
Delaware.....	329,382.87	15,000.00	29,050.12	13,000.00
Florida.....	329,966.11	15,000.00	31,996.19	13,000.00
Georgia.....	329,981.55	15,000.00	32,000.00	13,000.00
Idaho.....	255,000.00	15,000.00	29,117.93	13,000.00
Illinois.....	330,000.00	15,000.00	31,864.38	13,000.00
Indiana.....	329,901.19	15,000.00	27,000.00	13,000.00
Iowa.....	330,000.00	15,000.00	32,000.00	13,000.00
Kansas.....	330,000.00	15,000.00	32,000.00	13,000.00
Kentucky.....	329,996.57	15,000.00	32,000.00	13,000.00
Louisiana.....	330,000.00	15,000.00	32,000.00	13,000.00
Maine.....	329,999.62	15,000.00	32,000.00	13,000.00
Maryland.....	329,967.40	15,000.00	31,763.99	13,000.00
Massachusetts.....	329,617.70	15,000.00	32,000.00	13,000.00
Michigan.....	329,676.10	15,000.00	28,341.60	13,000.00
Minnesota.....	330,000.00	15,000.00	31,573.17	12,774.58
Mississippi.....	330,000.00	15,000.00	32,000.00	13,000.00
Missouri.....	325,097.24	15,000.00	32,000.00	13,000.00
Montana.....	240,000.00	15,000.00	29,417.04	13,000.00
Nebraska.....	329,932.16	15,000.00	32,000.00	13,000.00
Nevada.....	329,939.32	15,000.00	31,772.94	13,000.00
New Hampshire.....	330,000.00	15,000.00	32,000.00	13,000.00
New Jersey.....	329,961.97	15,000.00	32,000.00	13,000.00
New Mexico.....	294,998.90	15,000.00	32,000.00	13,000.00
New York.....	329,860.54	15,000.00	31,880.85	13,000.00
North Carolina.....	330,000.00	15,000.00	32,000.00	13,000.00
North Dakota.....	287,330.62	15,000.00	32,000.00	13,000.00
Ohio.....	330,000.00	15,000.00	30,514.02	13,000.00
Oklahoma.....	269,270.80	15,000.00	26,685.69	13,000.00
Oregon.....	316,631.82	15,000.00	27,000.00	13,000.00
Pennsylvania.....	329,967.43	15,000.00	31,995.41	13,000.00
Rhode Island.....	330,000.00	15,000.00	29,464.20	13,000.00
South Carolina.....	329,542.15	15,000.00	30,560.12	13,000.00
South Dakota.....	273,250.00	15,000.00	27,000.00	13,000.00
Tennessee.....	330,000.00	15,000.00	32,000.00	13,000.00
Texas.....	330,000.00	15,000.00	29,876.91	13,000.00
Utah.....	295,000.00	15,000.00	31,821.94	13,000.00
Vermont.....	330,000.00	15,000.00	32,000.00	13,000.00
Virginia.....	329,992.57	15,000.00	31,951.95	13,000.00
Washington.....	269,726.75	15,000.00	28,080.11	13,000.00
West Virginia.....	329,968.71	15,000.00	29,859.12	13,000.00
Wisconsin.....	330,000.00	15,000.00	32,000.00	13,000.00
Wyoming.....	315,000.00	15,000.00	32,000.00	13,000.00
Total.....	15,368,138.94	719,200.00	1,485,290.63	623,374.58

PROGRESS IN AGRICULTURAL EDUCATION, 1910.

By DICK J. CROSBY,
Specialist in Agricultural Education.

SUMMARY FOR THE YEAR.

Even the most cursory review of educational progress in 1910 is sufficient to demonstrate the world-wide extent of the movement for the promotion of agricultural education. It is unnecessary to do more than mention the countries and provinces that are becoming active in this movement—in Africa, Australia, China, Canada, Great Britain, India, and South America—some of which have long been identified with it and some of which, like those in Africa and China, are just beginning to take active part.

In the United States every agricultural department, bureau, and association—National and State—has been affected by the movement, and nearly every educational association has been compelled to take cognizance of it. The United States Department of Agriculture has found it impossible to supply the publications needed by the colleges and schools that are teaching agriculture or to meet satisfactorily the other demands they have made upon it for lectures, advice, and other assistance. And the Office of Experiment Stations, though it has added to the facilities of its agricultural-education service, has been unable to keep pace with the demands of the movement. To mention only one publication prepared in the office, a Farmers' Bulletin on Boys' and Girls' Agricultural Clubs, first issued in February, 1910, had gone through an edition of 110,000 copies by the end of June.

The agricultural colleges have nearly all had larger appropriations than formerly, and many of them have added to their buildings and other equipment, as well as to their teaching force, but in spite of this they find their facilities inadequate. Particularly is this true of their extension work and their teacher-training courses. Several colleges on private foundations have added courses in agriculture and others are preparing to do so as soon as they can get teachers. The same is true of the State normal schools.

The number of secondary schools teaching agriculture has increased rapidly, and the quality of agricultural teaching has improved. Particularly is this true in schools receiving State aid for

agriculture, where wise supervision has secured good teachers and suitable laboratory equipment and other illustrative material. A report to the National Education Association showed that 36 colleges and universities now accept a half unit or a unit of agriculture toward entrance requirements. This is as it should be, for while agriculture is taught in the secondary schools primarily for the boy who is not going to college, there is no reason why the colleges should hesitate or refuse to give credit for a subject now so widely taught, if it be well taught.

The details from which this brief summary has been made will be found in the following pages.

EDUCATIONAL WORK OF THE DEPARTMENT OF AGRICULTURE.

The educational work of the department continues to grow, and the demands made upon it for speakers, literature, and advice relating to school work in agriculture have been larger than ever before. As heretofore, the Office of Experiment Stations has represented the department in its relations with educational institutions, but the other bureaus and divisions have also done more than in former years to extend the general development of facilities for instruction in agriculture.

The work of the Weather Bureau school of instruction is described as follows in the report of the chief of that bureau:

The work of instructing probationary appointees has continued along the lines pursued during the previous year, except that more attention has been given to map making, especially the making of stencil or milliograph maps.

By the time they have finished their course of preliminary instruction at the central office the student observers have a fair idea of the method of handling official correspondence, and a number of them are quite proficient in sending and receiving telegraphic messages. Upon arriving at stations they are already qualified to make maps, take observations, prepare meteorological forms, and perform the various other station duties.

Thirty-six men received instruction during the past year, and all but eight had been given station assignments at its close.

The work of the Bureau of Animal Industry with reference to veterinary instruction in the United States was described in my last report. Referring to that matter in his 1910 report the chief of the Bureau of Animal Industry says:

As stated in my last report, the courses of instruction in the various veterinary colleges in the United States were investigated by two committees, and certain recommendations as to requirements for admission to the civil-service examination for veterinary positions in the bureau were approved by the Secretary of Agriculture and the United States Civil Service Commission, to take effect September 1, 1909. Most of the colleges have been disposed to meet the requirements of the regulations in order that their graduates may be eligible to the bureau service, and there has already been considerable improvement in

the courses and facilities at these colleges. The result is that not only is it possible for the bureau to obtain men better educated and qualified for its veterinary work, but the standard of veterinary education in the United States is being elevated.

The Bureau of Plant Industry has continued both lines of educational work described in my last report. These are referred to in the 1910 report of the chief of that bureau as follows:

School gardens.—The distribution of special collections of seeds for school-garden purposes has been continued on a very much larger scale during the past year than during any previous period. It has been possible to supplement the distribution by an additional collection of economic seeds, including the cereals, several important forage crops, fiber plants, and peanuts. The great demand for material for illustrating economic geography led to the assembling of this collection, which contains the 18 economic plants of greatest commercial value in sufficient quantity to enable teachers to plant demonstration areas illustrating the habit of growth of the crop, as well as to afford seed for laboratory study.

In addition to the seed distribution, plans for a number of school grounds offering instruction in agriculture have been provided. It is believed that this work will accomplish much toward the development of a taste for beautifying home grounds as well as public places, a taste which has too long remained undeveloped in our American people. The educational value of a well-planned school ground is not less than that of the instruction in the schoolroom, for it teaches not only the pupils themselves, but every passer-by.

Boys' clubs.—As previously stated, an increasing interest has been awakened in the boys' demonstration work carried on in cooperation with the public schools. The number of boys directly enrolled, as already referred to, now exceeds 46,000. In the fall of 1909 four winners of State prizes in the South received from private sources, as a part of their reward, a free trip to Washington, D. C., where they were presented with diplomas by the Secretary of Agriculture as a reward of merit for their good work. This has resulted in a similar prize of a trip to Washington being offered in every Southern State, and great interest has been aroused in these friendly contests in the production of corn. It is also noteworthy that in many places where the farmer can not be reached primarily the department has been able to reach him by enlisting his boy in the boys' corn clubs. It has been found that one year's experience of the boy in the corn clubs has almost universally resulted in enlisting the father as a demonstrator in better farming the next year, and this is true even where the father had declined to cooperate before his son was enrolled in the boys' contest and had proved the value of the improved methods.

The forester reports as follows concerning the educational work of the Forest Service:

Cooperation with schools and teachers was continued. Of 287 normal schools in the United States, 144 now include in their curriculum some teaching relating to forestry or tree study. By an arrangement entered into during the year, this cooperation is now conducted by the Forest Service jointly with and under the general supervision of the Office of Experiment Stations of the Department of Agriculture, since all work of the department related to agricultural education in the public schools is centered in that office. The Office of Experiment Stations is responsible for the general policy and methods of the work, while the Forest Service is responsible for the accuracy and sufficiency of the material from the standpoint of forestry.

Members of the staff of the Office of Public Roads gave 523 lectures, addresses, and papers in 28 States and the District of Columbia. With reference to the instruction in highway engineering given by the office, the director reports as follows:

The plan of appointing graduates of the leading engineering institutions to the position of civil engineer student in this office has been continued throughout the fiscal year along the lines previously followed. An examination was held March 9-10, 1910, under the auspices of the Civil Service Commission, and an eligible register established from which seven engineer students were appointed during the fiscal year 1910.

As evidence of the demand for competent highway engineers throughout the country, and the extent to which the engineers of this office are being utilized to meet this demand, it may be stated that during the past fiscal year eight engineers have resigned from the service to take up road work in various parts of the country.

The Secretary of Agriculture in his annual report for 1910 states that the publication work of the department exceeded that of any previous year, comprising 1,982 different bulletins, circulars, and reports, of which 25,160,469 copies were printed for distribution to farmers in every section of the United States. This was an increase of 46 $\frac{2}{3}$ per cent in the number of publications issued and 41 per cent in the number of copies distributed. Continuing he says:

The demand for these bulletins from educational institutions is increasing and is far in excess of the department's ability to supply. On account of the elementary character of the bulletins they are considered suitable for textbooks in schools of all grades, and such use of the information acquired by the department should be encouraged. The inevitable result would be a tendency to increase interest in agriculture in the minds of the young, which would influence them to remain on the farm. With the present appropriation, however, it is not possible to fully comply with requests received from this source.

The librarian of the department attended an important conference of the American Library Association at Mackinac Island, June 30 to July 7, 1910, at which two sessions of the Agricultural Libraries Round Table represented the first attempt to bring together librarians of agricultural libraries and those interested in agricultural literature for the discussion of their special problems. The librarian reports the following topics considered by the round table: (1) Agricultural libraries; (2) traveling libraries for farmers; (3) agricultural collections in public libraries; (4) agricultural literature in the reference library; (5) instruction of students in the use of agricultural and scientific literature; (6) relation of the experiment station library to the college library; (7) guides to recent agricultural literature; (8) classification of agricultural literature; (9) indexing agricultural literature; and (10) agricultural periodicals, their selection and preservation. The sessions were well attended, and the papers and discussions were interesting and helpful. At the close of

the meeting it was voted that the officers of the American Library Association be communicated with in regard to forming a permanent agricultural libraries section.

EDUCATIONAL WORK OF THE OFFICE OF EXPERIMENT STATIONS.

While the work of the Office of Experiment Stations in relation to agricultural colleges and schools was continued under the same general plan as in former years, the employment of an assistant in agricultural education throughout the year made it possible to complete several standing projects and undertake some new work. In this way gratifying progress was made in the preparation of publications for the use of teachers and in the study of some of the many problems arising in connection with the rapidly developing movement for instruction in agriculture. The astounding rapidity of this development was shown in a summary published in May, 1910, which showed that during the nineteen months preceding the number of institutions in the United States giving instruction in agriculture had increased from 545 to 875, or more than 60 per cent.

This increase in the facilities for agricultural education occurred largely among the secondary institutions—the agricultural high schools and the public and private high schools and academies, of which there were 630 with students in agriculture, not including normal schools and other institutions conducting teacher-training courses in agriculture, of which there were 214. Thirty of these latter were agricultural colleges for white students.

Such developments among the institutions that look to the agricultural education service of this office for publications and for advice concerning teachers, courses of study, equipment, methods of instruction, and in general the relation of their work to the practical problems involved in agricultural production and the satisfactory development of home and social life in rural communities have naturally resulted in very heavy demands upon this service, so that while a much larger volume of work has been done in the past year, it has not differed in kind very materially from that of former years.

There has been, as formerly, clearing-house work for these institutions, cooperation with them and with associations representing their interests, and expert services in connection with the inauguration of new agricultural educational institutions, courses, and projects. In this work the specialist in agricultural education has been aided by F. W. Howe, assistant in agricultural education; Miss M. T. Spethmann, in charge of statistics and the review of foreign literature on agricultural education, and Miss M. A. Agnew, in charge of the card directory of teachers and investigators in agriculture and of the organization lists of agricultural colleges and experiment stations.

RELATION TO AMERICAN INSTITUTIONS.

In addition to the regular editorial work of the agricultural education service in connection with the department of agricultural education in the Experiment Station Record, which involved the review of more than 3,000 American and foreign publications and the preparation of the annual organization lists, statistics, review of progress in agricultural education, and lists of education publications and institutions, the service has published special bulletins and circulars concerning secondary agricultural education, boys' and girls' agricultural clubs, forestry in nature study, normal-school instruction in agriculture, and testing seed corn in school, and has submitted for publication manuscripts dealing with a secondary course in animal production, school exercises in plant production, and school lessons on corn. One of the most helpful circulars issued was that giving a classified list of the free publications of the department which are suitable for the use of teachers of agriculture, home economics, botany, chemistry, and other sciences.

Studies of American and foreign schools in which agriculture is taught have been continued. The educational exhibit of this office which was prepared for the Alaska-Yukon-Pacific Exposition at Seattle has been sent to Argentina for exhibition at the International Agricultural Exposition at Buenos Aires. The card index relating to the American schools now contains over 6,000 cards. The card directory of American teachers and investigators in agriculture has undergone its annual revision and now contains about 2,100 names. In connection with the directory, a list of applicants for positions and a list of vacancies in institutions are kept closely up to date. The directory and these lists facilitate greatly the large correspondence of the office regarding the personnel of the institutions concerned.

Educational work in cooperation with the Association of American Agricultural Colleges and Experiment Stations has been continued. The director of this office has continued to act as bibliographer of the association, as chairman of its committees on instruction in agriculture and on the history of agricultural education, and was dean of the Graduate School of Agriculture, the fourth session of which was held at Ames, Iowa, during July, 1910. The specialist in agricultural education, as secretary of the association committee, has recently submitted for publication a secondary course in animal production, which was prepared for the committee by Prof. H. R. Smith, of the University of Nebraska.

The specialist in agricultural education and his assistant have attended many conferences and large educational gatherings and have assisted school officers and teachers in many ways through corre-

spondence and personal advice. The office has also occasionally sent out other members of its staff and specialists from other bureaus to address educational gatherings and to assist agricultural schools along their lines of specialization, and would employ this very effective method more freely if funds for travel were available. Cooperation with other bureaus of the department has also taken form in the preparation of educational bulletins and circulars. One circular prepared in the Forest Service has been published, and a bulletin on rural school consolidation, prepared by a special agent of the Bureau of Statistics, has recently come from the press. Cooperation along these and other similar lines might well be extended with resulting great benefit to the colleges and schools that are endeavoring to carry in an effective way to the people living upon the land the results of investigation on the part of this department and the State agricultural experiment stations.

RELATION TO FOREIGN INSTITUTIONS.

AFRICA.

Considerable progress was made in the introduction of agricultural schools and special features of agricultural instruction in several of the countries of Africa. In British West Africa an agricultural school and farm was established at Abuko. This institution is subsidized by the Government and managed by the Roman Catholic mission. The buildings, which include a dwelling for those in charge of the school and a school building with boys' dormitory attached, have been completed, and some experiments with cacao, coffee, kola nuts, and other products have been started. The pupils spend two hours a day in the classroom and the remainder of the time in the experimental garden and on the farm under the direction of the instructors.

In Egypt the director general of the Department of Agriculture and Technical Education has planned, built, and equipped eight trade agricultural and horticultural schools, each adapted to the special needs of its locality. School buildings in other localities are in process of construction. Most of the expenses have been met by voluntary contribution by the people in the Provinces. The applications for admission to the five schools completed in 1908 exceeded 2,000.

A farm school for girls has been established under the direction of Frau Helene v. Falkenhausen, at Brakwater farm, near Windhuk, in German southwest Africa. The purpose of the school is to give educated young girls the necessary training for colonial life in house and farm management with supplementary instruction in animal husbandry and poultry culture.

In Sierra Leone the late S. B. Thomas bequeathed the sum of \$291,600 (£60,000) for the endowment of an agricultural college at Mabang. The Government of Sierra Leone will cooperate in the management of the college, the director of agriculture occupying a professorial chair and the Government supplying three scholarships of \$243 each per annum for three years.

ARGENTINA.

The year 1909 was the first full year of the working of the new program of agricultural education started in 1908, and it is stated that the success of the enterprise has been marked. The existing schools are not sufficient to meet the demands of many young men who wish to study agriculture. The work of the different schools is localized to a considerable extent, e. g., Tucuman has its sugar school and Mendoza its wine-making school.

A new higher normal school has been established at Buenos Aires, with a three-year course for graduates of other normal schools or those who have completed similar studies. There is also a decree establishing rural normal schools in seven of the rural Provinces.

AUSTRALIA.

In New South Wales arrangements have been completed for the dairy instructors of the Department of Agriculture to give practical lessons in the testing of milk and cream to farmers' children attending the public schools in several different centers of the coastal region. At the conclusion of the course the pupils will be expected to take an examination to determine whether they have thoroughly mastered the principles of milk testing.

A number of dairy schools for factory managers have been held in different parts of the Province, the first at the Berry butter factory, the second at Lismore, and the third at Tamworth. At these schools there were daily lectures covering the manufacture of butter from a scientific standpoint, cream grading, cream and milk testing, the value of bacteriological tests to the manufacturer, etc.

In Queensland there is no agricultural instruction directly connected with the education department, but the Government provides a small grant for the encouragement of agriculture, horticulture, and kindred subjects in the State schools, while experts from the State college and farms periodically visit the schools in which elementary agriculture is taught and give instruction to teachers and pupils. In this and other ways a large number of teachers have secured a practical knowledge of milk and cream testing, and the subject is now regularly included in the program of instruction in several of the dairy districts.

The Government of South Australia has recently purchased 1,600 acres of land for the purpose of encouraging and demonstrating the best methods in dairy farming. A Government dairy expert will be placed in charge of the farm, and a dairy herd consisting of Jerseys, Shorthorns, Red Polls, Ayrshires, and Guernseys will be used for demonstration and instruction purposes. It is expected that students will be received and given instruction in all phases of dairy husbandry.

Victoria reports an interesting experiment in the reformatory treatment of boys from the neglected children's department by giving them a course in viticulture and general agriculture in the buildings and on the farms of the Viticultural College at Rutherglen. The boys are received at the age of 14 and held until they are 18. They are thoroughly trained in general farm work, dairying, and viticulture, as well as along general educational lines.

In one district of Victoria (East Gippsland) agriculture is now taught as the science course in 55 of the public schools, about 50 of these undertaking the work for the first time in 1909, and in most cases the work was considered very successful. The agricultural instruction is illustrated fully by a series of experiments in which the children's powers of observation and reasoning are carefully and systematically cultivated.

The University of Melbourne has inaugurated a course in agriculture, with W. A. Osborne, formerly professor of physiology, as dean of the faculty of agriculture.

BELGIUM.

An enactment signed by the King of Belgium November 9, 1909, establishes a special department of horticulture in that country. The councilors in whose hands the work of organizing the department has been placed are Messrs. E. de Meyer, E. Henriouille, and L. Joosens. This is believed to be the first definite department devoted exclusively to the interests of horticulture ever organized.

According to a recent report the number of clubs for farmers' wives in Belgium, which were first organized in 1906, increased from 36 in 1908 to 65 in 1909, and the attendance from 3,931 to 6,162.

BRAZIL.

A bureau of agricultural inspection has been organized in Brazil, which is to make a special study of agricultural conditions in that country, with a view to suggesting opportunities for improvement. It will have charge of the work of collecting and disseminating useful information among the farmers, promoting the introduction

of new crops or the extension of those already under culture, compiling statistics in agriculture and animal husbandry, making crop estimates, and inspecting the agricultural schools and experiment stations. For the purpose of carrying out its work the country will be divided into 12 districts, with an inspector in charge of each.

BRITISH ISLANDS.

In accordance with the recommendations of the special committee appointed by the president of the Board of Agriculture and Fisheries (Progress in Agricultural Education, 1909, p. 258), the relations between the Board of Agriculture and Fisheries and the Board of Education with reference to the promotion of agricultural education in England and Wales have been defined by a "memorandum of arrangements" between these departments. According to the terms of this memorandum, the purpose of which is to prevent overlapping or duplication of work in agricultural education, the Board of Agriculture and Fisheries will hereafter distribute all grants to institutions giving instruction to students in advanced courses in agriculture and to institutions restricted to one special phase of the subject, such as forestry, dairying, cider making, the main purpose of which is to prepare competent instructors in that phase of agricultural work, and the Board of Education will distribute all grants in aid of other forms of agricultural education. In the case of farm schools having farms and experiment stations in connection with them, the Board of Agriculture and Fisheries will render the necessary Government supervision and aid for the farms and stations, and the Board of Education that for the educational work of these schools. To aid in correlating the work of the two boards an inter-departmental committee has been provided for, to consist of responsible officers of the boards, who will consider all questions in which the two boards are mutually interested.

The conditions relating to agricultural research in England have been greatly improved by the law known as the "development and road improvement funds act" of 1909. This act empowers the Treasury, upon recommendation of the commissioners appointed under it, to "make advances to a Government department, or through a Government department to a public authority, university, college, school, or institution, or an association of persons or company not trading for profit," for the following purposes, among others: "Aiding and developing agriculture and rural industries by promoting scientific research, instruction, and experiments in the science, methods, and practice of agriculture." Every application for an advance other than from a Government department is to be sent "by the Treasury to the Government department concerned, to be by them referred, together

with their report thereon, to the development commissioners." To enable the Board of Agriculture and Fisheries to deal effectively with applications coming under its jurisdiction, an advisory committee on agricultural science has been appointed, which will submit reports on application to the board.

According to a report issued in 1910 the grants awarded by the Board of Agriculture and Fisheries for agricultural instruction in England and Wales amounted in 1908-9 to \$58,320 and in 1909-10 to \$59,778. There were also special grants for experimentation and research amounting in 1908-9 to \$4,423 and in 1909-10 to \$2,916. Grants for experimentation have been given for a number of years, but not until 1908-9 was there any grant to an institution for research work—a grant of \$972 to the University of Cambridge for cereal-breeding investigations.

It is announced that a well-known firm of shipping agents in London has established Craig Wood Lodge colonial training farm at Horsted Keynes, Sussex County, England, for the purpose of testing the capacity and fitness of young men wishing to go to the colonies. The farm comprises 20 acres and is said to be well equipped with live stock, poultry, fruit, kitchen garden, etc. At present there are accommodations for 15 pupils. The instruction is entirely practical, covering the elements of mixed and dairy farming. The course extends over two months, and if at the end of that time the pupil is found adapted to colonial farming the firm undertakes to place him with a reliable farmer in Canada or Australia.

The new building of the school of agriculture at Cambridge University was formally opened April 26, 1910, by the Duke of Devonshire. The building is an imposing three-story structure in addition to the basement and attic, and contains three lecture rooms, two large elementary laboratories for chemistry and botany, smaller rooms for private research, and a library and offices. The cost of the building was about \$100,000. It was designed to accommodate 100 students, but is already barely adequate for the needs of the work.

According to the ninth annual general report of the Department of Agriculture and Technical Instruction for Ireland, there was an increase in the number of itinerant instructors in agriculture, horticulture, beekeeping, poultry keeping, butter making, rural domestic economy, and other subjects, and an increased attendance at the winter agricultural classes, the schools of rural domestic economy, and the summer courses for teachers held in July and August at various institutions.

BRITISH WEST INDIES.

Arrangements have been made in Antigua and St. Kitts for cooperation between the public grammar schools and the botanical and

agricultural experiment stations for the education of a limited number of boys who in the last year or two years of their grammar-school work may spend a large part of their time at the stations. This work at the stations is regarded in the nature of a scholarship. As the boy progresses in his work he may be placed in charge of some section and may be paid a small amount, although it is definitely understood that this payment is not to be regarded as wages. All this time, however, he is definitely connected with the grammar school and is carrying on a part of his work there. It is expected that this will prepare young men to take up responsible work as overseers of estates.

According to the report of the instruction in school gardens in Jamaica, interest in this form of agricultural instruction is rapidly extending. In 1909-10 about 24,000 children were taught something about agriculture through the means of these gardens.

Toward the close of 1909 the buildings formerly used for an industrial school at Hope, Jamaica, were remodeled and a farm school was established in them. Provision was made for 25 resident students and suitable shelter was provided for sheep, pigs, and other farm animals and poultry.

The board of education in Granada pays special bonuses to teachers for instruction in practical agriculture and for instruction in sanitation and hygiene. The efficiency of the instruction in these subjects is determined by examination of students conducted by the board.

In Trinidad practical agriculture is now taught in nearly all boys' schools and coeducational schools. Omitting 9 schools for girls, 3 kindergarten schools, and 9 others whose teachers being women naturally attract a preponderance of girls, of the remaining 219 schools, 210 give instruction in agriculture. The instruction consists of school garden work and nature study, and in several schools simple experiments in plant culture, composting, nursery work, and seed germination. Agriculture is a compulsory subject in the annual examination of teachers. Thirty teachers in elementary schools received instruction in agriculture during the year.

CANADA.

A royal commission on industrial training and technical education for the Dominion of Canada has been appointed, with Dr. James W. Robertson, formerly principal of Macdonald College, as its chairman. This commission is engaged in a study of agricultural and other industrial, as well as educational, conditions in foreign countries, with a view of obtaining information that will be of value in developing agricultural education and in conserving Canada's national resources.

The University of Alberta, at Strathcona, has accepted plans for a building 230 feet long by 70 feet wide, with wings on the north and south ends 110 by 30 feet. It is not expected that the building will be completed inside of three years, and the cost is estimated at approximately \$500,000.

At the last meeting of the university senate the report of the executive committee regarding the organization of the agricultural college recommended the establishment of the following departments: Animal husbandry, agronomy, dairying, agricultural engineering, bacteriology, and veterinary science. In addition the departments of chemistry, biology, and geology will be common to the faculties of both arts and agriculture. It was decided to proceed with the organization of the agricultural faculty along the three following lines: (1) By the completion of the establishment of the agricultural faculty within the university at the earliest possible date; (2) by the establishment of a system of permanent secondary schools in connection with demonstration farms in those sections of the Province not coming within the immediate scope of the college itself; and (3) by the development of a department of extension teaching. The university work will not be confined to teaching, but will include research work in connection with the various agricultural problems of the Province.

In Saskatchewan last year about 160 agricultural meetings were held under the auspices of the agricultural department, and it is expected that this number will be greatly increased the coming year.

The Manitoba Agricultural College has established a department of household science to be under the direction of Miss A. B. Juniper, formerly dean of the school of household science in Macdonald College.

In Ontario the work of the agricultural teachers, who are also scientific advisers to farmers in the vicinity of the public high schools in which they teach, was so successful that three more such teachers have been appointed.

A school of forestry has been established in connection with the University of Laval at Montreal. The course is open to college students having a bachelor's degree, and extends over two years.

CHINA.

An agricultural school has been started by the Government officials at Mukden, Manchuria. The school has 300 acres of land and an annual appropriation of \$150,000 for maintenance. E. C. Parker and W. H. Tomhave, of the University of Minnesota, were engaged to inaugurate the agricultural work.

The German-Chinese High School at Tsingtau at the beginning of February, 1910, had 102 students in its various agricultural and for-

estry courses. This school is maintained jointly by the German and Chinese Governments, the latter having appropriated \$9,250 for equipment and a like amount annually for 10 years for maintenance. There are both Chinese and European instructors.

COLOMBIA.

By official decree, five additional normal schools have been established. The curriculum prescribed for these normal schools includes, among other subjects, the principles of agriculture.

FINLAND.

Training schools in agricultural cooperation have been organized in Finland. Six such schools were recently held for the purpose of giving instruction to the members of the smaller cooperative societies relating to cooperative law, consumers' societies, cooperative dairies, credit banks, and cooperative purchasing societies.

FRANCE.

Partly as a result of the influence of a special report to the French minister of agriculture by Prof. Henry, of the National School of Horticulture at Versailles, on special instruction for farmers' daughters, quite a number of French departments are now maintaining traveling domestic-science schools. In December, 1909, there were 10 such schools. The principal subjects taught include hygiene, domestic economy, child study, morals, agricultural dairying, animal hygiene, poultry culture, beekeeping, and farm and home accounts.

Encouragement is also being given in some of the departments for elementary agriculture and domestic science in the schools. In three departments in 1909-10 cash prizes of \$96.50 were offered to the teachers who gave their pupils the best instruction in domestic science.

An agricultural institute has been established in connection with the University of Toulouse.

GERMANY.

Several of the German States are giving considerable attention to cooperation among farmers, itinerant instruction in agriculture, and instruction in gardening for women. The German Imperial Union of Agricultural Cooperatives conducts an agricultural cooperative school at Darmstadt each winter, the course including a general survey of the present status of cooperation in Germany, the cooperative sale of dairy cattle and milk, information resulting from cooperative inspection, cause and effect of lessons to be derived from the last financial crisis, and agricultural cooperation in the German colonies.

The German Agricultural Society conducts every three years a course for itinerant agricultural instructors. The course held March 31 to April 6, 1910, at Eisenach, was attended by 350 instructors. At each session a special subject is considered. The 1910 session took up the subject of rural economy in its various branches, such as farm management, the present status of rural economics, rural continuation schools, and agricultural instruction in the army.

The minister of agriculture has decided to encourage women to take up gardening as a profession and has arranged that the horticultural institutes at Geisenheim, Proskau, and Dahlem shall admit women not only to the courses of instruction, which they have done heretofore, but also to the final examinations. Somewhat along similar lines the horticultural institute at Geutlingen has established courses in fruit utilization for girls. A dairy school for women has been established at Strausland.

Another phase of instruction in fruit utilization is that given in canning and preserving by the institutes of gardeners and orchardists at Dahlem, Geisenheim, Proskau, Oranienberg, and Oberzwehren. The instruction in these institutes goes into such matters as the manufacture of canned goods and preserves, fruit juices, wines, jellies, kraut, marmalades, jams, and pickles, and also the essential facts in connection with the selection and cultivation of vegetables and fruits for manufacturing into these products. Other matters which are considered are the causes of spoilage and their remedies, the principles of buying and storing raw materials, and the storing, packing, transportation, and sale of the products.

INDIA.

The Tropical Agriculturist and Magazine of the Ceylon Agricultural Society for October, 1909, announces the completion and dedication of the agricultural college at Coimbatore, which was authorized by the Government of India in 1905. A farm of 450 acres has been under cultivation during the past two years, and 20 students were admitted in June of this year. The course of training extends through three years and includes theoretical and practical instruction in general agriculture, entomology, agricultural engineering, veterinary science, and kindred subjects, with special provision for research investigations. The present staff consists of an expert agriculturist, a botanist, and an agricultural chemist, and eventually will include an entomologist and mycologist.

The new agricultural college at Lyallpur, Punjab, was opened September 1, 1910, with a class of 16 students, which were all that could be accommodated at the time. There were 574 applications for admission.

JAPAN.

Higher schools of agriculture and horticulture were opened in September, 1909, at Chiba and Kagoshima. These schools offer three-year theoretical and practical courses which articulate with the courses in the lower schools, i. e., the middle school of five years which is preceded by the primary school of six years.

MEXICO.

There has been notable progress recently in the development of agricultural interests in the Department of the Promotion of Public Works. What was formerly the division of agriculture has been organized into a bureau of agriculture in charge of a director general of agriculture. The bureau consists of five divisions: (1) Agricultural education, agricultural experiments, plant diseases, and animal industry; (2) agricultural propagation; (3) rural economics and agricultural statistics; (4) forestry, and (5) biological investigations. Each division is in charge of a chief. As in the United States, the Federal departments in Mexico can regulate educational affairs only in Federal territory. There is a Federal law requiring that elementary agriculture be taught in all of the primary schools of Federal districts and territories in accordance with regulations promulgated by the department of public instruction. Secondary agricultural instruction will be given in the local agricultural schools in connection with experiment stations, which are or will be established in the States and Territories and will be under the direction of the Department of the Promotion of Public Works. Higher agricultural instruction is given in the National School of Agriculture and Veterinary Science. The secretary of the promotion of public works is authorized to give subsidies to public and private institutions giving instruction in agriculture, and the curricula of such institutions are subject to the approval of the secretary. The plans of the new bureau of agriculture include short courses in agriculture at the National School of Agriculture and Veterinary Science, and also at the experiment stations and at other agricultural centers. Traveling instructors will be employed.

A Federal school of forestry was opened in June, 1909, at a point about 15 miles west of the City of Mexico, and a private school of agriculture was established near Villa de Tanhuato de Guerrero by Senora Serrano, who contributed about \$120,000 (Mexican) for the erection of a building for the purpose.

ROUMANIA.

In order to encourage agricultural instruction in Roumania the Department of Public Instruction has decided to reduce the military

service of former pupils of elementary agricultural schools to one year. This advantage will also be given to young men who can pass an examination equivalent to one year's work in agriculture in these schools.

WEST INDIES.

An estimate was included in the Cuban budget for 1910-11 of \$112,200 for the maintenance of the six agricultural schools authorized for the several Provinces by an act passed July 12, 1909.

Under a law recently signed by President Caceres, a general board of agriculture and immigration was established in Santo Domingo. This board will have supervision of all schools of agriculture, both public and private. An agricultural laboratory and an experiment station are contemplated, and the more general dissemination of agricultural literature is to be taken up.

EDUCATIONAL WORK OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The twenty-third annual convention of the association was held at Portland, Oreg., August 18-20, 1909. The report of the executive committee called attention to the importance of more general support of the Graduate School of Agriculture. In reply to an inquiry as to whether the pension of a professor partly engaged in research work would be based on his whole salary or only on the part which he receives for teaching, President Pritchett, of the Carnegie Foundation, stated to the committee that in his judgment—

the trustees of the foundation would never make any discrimination in such cases so long as the professor concerned did a certain amount of teaching.

In his report as bibliographer, A. C. True, of this office, discussed the station library and its use. He pointed out the need in many cases of more systematic attention to the library and bibliographical work, and urged that the station should have, if possible, the services of some person trained in library and bibliographical matters who may give his time and energy quite fully to the special requirements of the station along these lines. In addition to the collection, safeguarding, filing, and general care of the documents and publications bearing on the work of the stations—

the station investigations may be greatly aided and promoted by having some person who can assist in looking up references, in making excerpts, and in making and taking care of indexes and doing bibliographical work of a miscellaneous character. * * * To cover this work the stations do not need a librarian simply, in the ordinary acceptance of the term, but rather what may be called a bibliographical aid, some one who has some scientific knowledge and who is properly trained so as to give efficient aid in bibliographical matters to the station staff.

The committee on graduate study reported progress in the organization of the next Graduate School of Agriculture, which was held at Iowa State College at Ames, with A. C. True of this office as dean. A plea was made for more general subscription for the support of the school.

The report of the committee on instruction in agriculture, presented by A. C. True, briefly referred to a proposed outline of courses in animal husbandry and dairying. Dr. True also presented a brief report for the committee on history of agricultural education, embodying certain data regarding the early development of agricultural education in Illinois, Michigan, New York, and South Carolina.

The following resolution, originating in the college section, was adopted by the association:

That it is the sense of this association that the national laws which constitute the charter of the land-grant colleges distinctly prescribe work of collegiate grade in agriculture and the mechanic arts, including engineering in all its branches, and the science related to the industries, irrespective of whether the colleges are established separately or as parts of universities.

An interesting discussion of the important subject of agricultural education in secondary schools was opened by Dr. True, in a paper in which he reviewed the present status of the subject, classified the institutions giving secondary instruction in agriculture, and suggested ways in which such instruction could be developed in harmony with the present educational systems of the country. He summed up his views of what he considered perhaps ideal conditions as follows:

Agriculture, including horticulture and forestry, should be a regular part of public secondary education; second, the unity of our educational system should be maintained, but there should be sufficient elasticity of curriculum to meet the various needs of our people; third, the standard of the curriculum of secondary schools having agricultural courses should conform in a general way to those adopted for the general school system of the State; fourth, the standard agricultural courses, whether in the ordinary high schools or in special schools, should not be narrowly vocational, but should aim to fit the pupils for life as progressive, broad-minded, and intelligent men and women, citizens and home makers, as well as farmers and horticulturists.

Some disapproval of separate and distinct agricultural high schools was expressed in the general discussion which followed, but there seemed to be quite general agreement that in any case the agricultural instruction should be carefully coordinated with the existing educational systems. L. H. Bailey, of New York, thought that in the discussion of this subject a clear distinction should be made between what is strictly secondary instruction and what is merely special training. The importance of separate agricultural high schools as finishing or vocational schools, and as a means of training teachers of agriculture for the elementary schools, was also brought out in the course of the discussion. The general views expressed in Dr.

True's paper were indorsed by formal vote of the convention, and the advance publication of the paper was requested.¹

An address was delivered by L. H. Bailey, of New York, on *The Better Preparation of Men for College and Station Work*. The subject was discussed from the fourfold standpoint of the necessity of (1) developing a spirit of scientific inquiry, (2) letting one's work propagate itself, (3) developing an incentive of self-help in one's constituency, and (4) insisting on a certain kind of preparation in the college. The necessity for a broad educational foundation was emphasized with special force, and too early or narrow specialization was strongly deprecated. The need of greater facilities than are now available for the broad and thorough postgraduate training of specialists was pointed out. The attitude of the investigator or instructor toward his work was considered "just as important as the work itself," and it was urged that no person can be considered prepared for college or station work who does not possess the scientific spirit. "We may well rest content that our work will propagate itself if the work is well done and enthusiastically presented." The best work for State or National constituency is that which inspires that constituency to help itself.

Prof. Bailey thought that only maturer and more experienced men should be put in full charge of very responsible work and that more time should be given to the training of persons for such work. The equivalent of a good high-school training, a regular four-year college course, and a thorough postgraduate training, leading first to a master's degree and ultimately to a doctor's degree, was considered necessary. "In order that a postgraduate degree may mean something, it is important not only that the postgraduate work itself is good, but that only those persons be allowed to candidacy who give evidence of being intelligently able to pursue the work with satisfaction."

The report of the committee on extension work, presented by K. L. Butterfield, of Massachusetts, advocated the formation of a new section of the association on extension work, a Federal appropriation to the States and to the United States Department of Agriculture for extension work, the franking privilege for extension publications, and the organization of separate extension departments by the land-grant colleges. At a later session of the convention the recommendation with reference to amendment of the constitution to provide for a section on extension work was taken up, and after discussion was adopted by formal vote. This amendment provides for "a section on extension work composed of directors or superintendents of extension departments in the institutions in this

¹ U. S. Dept. Agr., Office Expt. Stas. Circ. 91.

association, or the representatives of such departments duly and specifically accredited to this section." The other recommendations of the committee were approved.

The report of the committee on station organization and policy was confined to a consideration of methods of dissemination of the results of station investigations and dealt with the questions of improving present means of publication and of securing a common medium of publishing the results of station research work. In the opinion of the committee, "every legitimate effort should be made to aid the agricultural press in presenting the station work to the people at large in a popular form. To this end, abstracts of bulletins should be furnished to the press and also illustrative material by way of cuts, charts, etc." The committee also advocated greater attention to the organization of cooperative and demonstration work and recommended that short normal courses be held at the colleges or independent stations prior to the beginning of the farmers' institute season.

The report expressed the opinion that the bulletins should be confined to the results of research and a general description of the work, should bear the date of publication, and should be paged continuously throughout a given volume, each volume to have a table of contents, title-page, and complete index, so printed that they can be easily removed and placed in proper position without cutting to single pages. Electrotyping was advocated, to permit of reprints.

All publications dealing with inspection work of whatever kind should be published under a series known as official inspections. * * * The annual report, if merely embracing the financial statements and a brief summary of the work of the year, should be issued as a bulletin. If it is of large size and is made a repository of matter of permanent value, it should have its own table of contents, title-page, and index.

The committee strongly advocated the establishment of a journal of agricultural research and outlined in considerable detail a plan for the management and maintenance of such an organ. This plan was indorsed by the association and the matter was placed in charge of the executive committee, with authority to act.

A report of the committee on affiliation of agricultural organizations was presented by H. J. Waters, chairman. The report favored affiliation and indorsed the resolution of the Society for the Promotion of Agricultural Science, inviting the affiliation of several agricultural organizations and outlining a basis for such affiliation. The proposed plan insures the full autonomy of the separate societies, but provides for a representative council, affiliated meetings just preceding those of the Association of American Agricultural Colleges and Experiment Stations, and an annual report by the council.

In the section on college work and administration the following topics were discussed: (1) The distinctive work of the land-grant colleges—their function, scope, and organization; (2) Entrance requirements and standards for land-grant colleges; (3) Function of land-grant colleges; and (4) How can the agricultural colleges best serve the farmers in solving rural problems?

The first topic was presented in a paper by A. B. Storms. He believed that the independently established colleges were more distinctly typical of the norm contemplated in the original Morrill law than those established in connection with State universities, and that there are good pedagogic and administrative reasons for maintaining them as separate institutions. In reference to organization he favored a strong organic unity of all the college departments as against a degree of independence that encourages "department provincialism." The ability of men, especially of the heads of coordinate departments, to work and fit with other men without friction was emphasized as a necessary requisite in the working compromise that must always be made between technical and administrative efficiency. The speaker deprecated the zeal for large enrollments at the expense of entrance requirements sufficiently advanced to insure thorough college work, and he believed that the land-grant colleges could not consistently do less than to insist upon four years of approved high-school work as a condition of entrance.

The discussion of this paper was led by E. A. Bryan and Howard Edwards. The former emphasized the fact that the entire group of separate land-grant colleges and land-grant departments of State universities together constitute the basis of a national system of education. He believed this solidarity of interests should be fostered among the institutions represented in the association and cautioned against a too narrow conception of the scope of education contemplated in the land-grant acts. For example, the teaching of agriculture in all productive lines is much further advanced than is the teaching of methods for distributing and marketing farm products in an economic way.

President Edwards's contribution to this discussion was mainly directed to the formulation of an answer to the question which had been asked him by the president of the Carnegie Foundation: What is the definite function of the separate agricultural colleges? He called attention to the more restrictive language of the act of 1890 as compared with that of 1862, and proposed a resolution designed to express the understanding of the association on the subject of the question (see p. 332).

President Butterfield raised a question concerning the proper place for college-extension work and its director in the functions of the

college. President Storms held that the head of each main department of the college should have general oversight of the instructional, research, and extension work of his department, each of these phases being more particularly in the hands of an assistant, and that the general director of the extension department should cooperate with the other department heads and their subordinate assistants in charge of extension work.

The entrance requirements and standards for land-grant colleges was presented in a paper by J. L. Snyder. He believed that entrance requirements were purely a local problem, dependent in each State upon the advancement of the secondary schools within reach of the people; but that graduation requirements should be practically uniform in all the colleges and in keeping with traditional understandings in regard to the worth of academic degrees. The speaker particularly deprecated the tendency to alter land-grant college entrance requirements in order to meet the conditions of pension benefits on the Carnegie Foundation.

As the public educational system develops in each State standards for college entrance will advance. They should be sufficiently high to serve as a stimulus to secondary schools, but not so far advanced as to create a gap between the public-school system and institutions of higher learning.

W. E. Stone heartily indorsed the main features of this paper and emphasized further the view that the high schools of a State have an independent duty toward their constituencies as finishing schools for those who do not go on to college. He believed that "the colleges should adjust their requirements to what is proper for the high schools to do."

President MacLean emphasized the necessity of frequent readjustment between the school, whether secondary or collegiate, and its constituency. The uniformity which has become almost standard throughout the country must be tempered with a variable content in the curriculum which is specially adapted to local conditions.

Under the third topic, H. J. Waters discussed the Function of Land-grant Colleges in Promoting Collegiate and Graduate Instruction in Agriculture Outside of the Course of the Graduate School. In a rapid survey of the development of college work in recent years he pointed out the fact that the pressure of attendance and of outside calls for information had seriously hindered the development of superior teaching and further research.

We have been giving the world the benefit of the discoveries of science for the past fifteen or twenty years; * * * but to do this alone or even chiefly is fatal to progress. The farmer will soon catch up with the college teacher, and then all opportunity for leadership is lost.

The speaker held that upon the experiment station devolves the duty of "making an exact science of agriculture." Higher standards

of teaching will now be required, as well as better equipment for research. He believed that the resources of the experiment station should be utilized in developing graduate work and gave illustrations of how this had been done in his own college. The paper closed with the suggestion that the Department of Agriculture demand graduate preparation for its employees, in order effectively to encourage graduate study in the colleges.

In discussing this paper L. H. Bailey emphasized the thought that careful discrimination must be used in determining what men should be permitted to take graduate work, so as to eliminate those who have a history of failure or inefficiency. He would allow no station workers employed on Hatch or Adams funds to have any stated part in undergraduate instruction, but would use their abilities in graduate teaching germane to the lines of their own research work.

The second division of this topic, *The Function of the Land-Grant College in Promoting Agricultural Education in Secondary Schools*, was presented by E. A. Burnett. He maintained that the college can not escape the responsibility of directing the lines along which progress is made. Of the two methods so far proposed for meeting the recognized demand for secondary industrial work, namely, the addition of agricultural courses in ordinary high schools and the establishment of distinctive agricultural high schools serving an area of several counties the first method, as so far illustrated in certain Nebraska high schools, he did not consider at all adequate to the requirements. The agricultural high school he believed likely to be deficient on the cultural side, unless it duplicates much of the literary work of the ordinary high school. To avoid this undesirable duplication, he favored the institution of strong secondary agricultural courses and equipment in connection with existing high schools favorably situated for serving a large country constituency. Where such courses are located in connection with agricultural colleges the speaker believed they should take over a considerable part of the technical agricultural work of secondary grade, thus permitting the strengthening of the purely collegiate work in agriculture; but he did not regard such schools as the proper type for isolated agricultural high schools. He believed that the distributed establishment of secondary agricultural schools would ultimately strengthen the support given to the colleges.

In discussing this paper, Dean Davenport contended that there is no need for the establishment of distinctive agricultural schools for secondary work. He described the public-school men as ready and anxious to introduce agricultural courses in order to hold the boys who are deserting the ordinary high schools for work which appeals more strongly to their interests. He illustrated his remarks by several successful examples in his own State, and cited the case of Min-

nesota, with 65 high schools applying for the privilege of introducing an agricultural course with State aid when the law permitted only 10, as another emphatic illustration of the trend of public-school sentiment. The task now is to put vocational agriculture "within walking or riding distance" of every boy on the farm, and he believed the high schools are ready for this expansion.

E. J. Wickson presented the fourth topic of the program, on the relation of the agricultural colleges to the solution of rural problems. It was contended that "the truth which our agriculture now most urgently needs is not to be gained by extending investigation in the physical sciences nor in the application of the results to agricultural practice, though both are desirable." Research is now needed in rural economics and sociology. Prof. Wickson urged, therefore, that the agricultural colleges should broaden their research and instruction in such subjects as economics and social science, and that in universities with agricultural courses these subjects should be treated from an agricultural point of view.

Discussing this subject, J. H. Worst emphasized the importance of teaching the "hereditary farmer" ways of utilizing the developments of modern science for equipping the rural home with domestic and sanitary conveniences; and A. B. Cordley held that the best assistance that can be given the farmer is a local demonstration of the commercial success of a scientific system of farming adapted to his own conditions. Such a system must be so devised as not only to be profitable to the individual farmer, but also to conserve and increase the fertility of the soil. It can not be regarded as successful if it fails in either of these respects.

WORK OF THE NATIONAL EDUCATION ASSOCIATION.

The Boston meeting of the National Education Association, July 2-8, 1910, included, as have several of the earlier conventions of the association, many papers and discussions relating to agricultural education. J. Y. Joyner, in his annual presidential address on Some Dominant Tendencies in American Education, called attention to the fact that "any educational system to be vital and useful in a democracy must have its roots in the life and needs of all the people, and must be shaped in accordance with the demands of the present and the ideals for the future." He called attention to the fact that recently it has occurred to those responsible for school policy that the public schools of the various grades were fast becoming merely preparatory schools, each for the next school above it in rank, and that little attention was being given to the type of work which would "fit the common man to meet and solve the common, everyday problem of his life, and to lift his life to a higher plane of efficiency, service, and happiness." He characterized the passage of the land-grant acts and

the establishment of colleges in accordance with them as "the democratization of the courses of study in colleges and universities," and believed that it was inevitable that a demand for a similar democratization of the work in the public schools should be brought about by the teaching of vocational subjects in these schools. He pointed out that every man needs and should be provided two sorts of education, one to fit him to work and the other to fit him to live, and that the two sorts should be combined in the same system of schools. He expressed the opinion that it would be "a fatal blunder to permit in our system of American education the establishment and maintenance of entirely separate systems of vocational or trades schools."

H. L. Russell, dean of the college of agriculture of the University of Wisconsin, gave an illustrated address on *The Value of Demonstrative Methods in the Agricultural Education of the Rural Population*, in which he described the short courses held at the University of Wisconsin, the extension courses conducted at county agricultural schools and elsewhere, and the demonstration work conducted throughout the State on county demonstration farms and elsewhere.

The former president of Harvard University, Dr. C. W. Eliot, gave a notable address on *The Value During Education of the Life-Career Motive*. This motive he believed should be present even in the elementary schools, and particularly should it be apparent in schools attended by boys from 16 to 20 years of age. He called attention to the difficulty of sustaining the interest of all the pupils in a single course of study, especially the old classical or college preparatory course; developed the fact that in the rural districts and in small towns where there are only one or two important industries a large percentage of the pupils adopt the vocation of their parents, a vocation which is usually agricultural or industrial, and argued from this that certainly in such communities, if not in others, the elements of the arts applicable in ordinary households "and in various trades or callings ought to be carefully taught in all schools, public, endowed, or private, such as drawing and designing, domestic science and art, and home economics, carpentry, and joinery, and in rural communities, agriculture." The importance of providing various forms of training which children between the ages of 12 and 16 will see the future use of was emphasized.

The department of rural and agricultural education held two independent section meetings and one joint session with the departments of secondary education and science instruction. At the first session the problems of field laboratory work for courses in agriculture and horticulture were considered. R. L. Watts, of Pennsylvania, discussed *Field Laboratory Work Accompanying College Courses in Horticulture*, and described the various types of such work as (1) resident work, including craft work, such as sowing seeds, trans-

planting, grafting, budding, etc., observation work in the college orchards, gardens, nurseries, greenhouses, etc., and vocational work, in which the student is told to make a vegetable garden, a flower garden, or a nursery, and (2) nonresident work, including farm experience, which in some places is made a requirement for graduation, inspection trips, one of which extended from Pennsylvania State College to Philadelphia, several points in New Jersey, Kennett Square and West Grove, Pa., Baltimore, Washington, and Norfolk, and survey work, in which the students undertake different horticultural surveys and are furnished written instructions and information blanks to be used in making the surveys.

A short paper on an Experience in Field Work in a Well-established School of Agriculture was read by K. C. Davis, in which the field laboratory work as conducted at the Dunn County Agricultural School was classified and briefly described. This included work with soils, plants, animals, buildings, machinery, and other farm equipment.

Laboratory and Field Work in the Agricultural High School was the subject of a paper by B. H. Crocheron, who called attention to the difficulty of organizing work of this kind owing to the lack of any very definite precedents, and then described in some detail what might be called the community work of the agricultural high school of Baltimore County. This included work with school-teachers, farmers, farmers' wives, and young people not in school.

The second session of the department was devoted to papers on agriculture in the public-school system. G. F. Warren discussed The Place of Agriculture in the Public High Schools, and in an introductory way showed the economic value of education as indicated by an investigation made in several townships in New York concerning the labor income of all the farmers. In this investigation whatever might be called income from other sources, such as interest on investments and income from hired labor, was eliminated in the compilation, which was intended to show merely the income of the farmer from his own labor. The result of the investigation was shown in the following tables:

Labor income of 573 farmers in New York.

	Number of farmers.	Average labor income.
Attended district school only.....	398	\$318
Attended high school or equivalent.....	165	622
Attended college or university.....	10	847

Labor income of 573 farmers in New York, arranged in capital groups.

Capital.	Average labor income of farmers with district-school education.	Average labor income of farmers with more than district-school education.
\$2,000 and under.....	\$187	\$286
\$2,001-\$4,000.....	241	275
\$4,001-\$6,000.....	398	406
\$6,001-\$8,000.....	395	709
\$8,001-\$10,000.....	618	796
\$10,000-\$15,000.....	525	1,091
Over \$15,000.....	1,054	1,272

Dr. Warren recognized two ways of providing secondary instruction in agriculture, one through separate agricultural high schools and the other through the introduction of agriculture into the present high schools. He believed that a few special agricultural high schools might be desirable, but thought it would be unfortunate to segregate students in that way. He preferred the introduction of agricultural courses into existing schools, to be studied to some extent at least by all students. He argued that agriculture would be a valuable cultural subject to the boy who was to become a preacher, or doctor, or teacher, and a vocational subject to the boy who would become a farmer.

As to who should teach agriculture, Dr. Warren was strongly in favor of a special teacher of the subject. He recognized the fact that many of the principles of agriculture could be taught by the teachers of botany, physics, chemistry, and other sciences, but showed that even if all of the science teachers were to teach the relations of their subjects to agriculture the result would not be agricultural instruction. To illustrate this he asked:

How would the teaching of a crop rotation proceed if there were no special teacher of agriculture? Crops are rotated to control weeds, to control insects, to control fungi, to keep up the humus supply, to secure the benefits of growing grasses and legumes on each field, for convenience in working, and for control of toxic substances. Possibly the botany teacher might mention weeds, fungi, legumes, and grasses in this connection, and might even discuss toxic substances; the teacher of zoology might mention crop rotation as a means of controlling insects; but to have these points mentioned at various times and in a disconnected way would not teach the importance of crop rotation.

D. J. Crosby read a paper on *The Place of the Agricultural High School in the System of Public Education*. He pointed out two essentials in a system of universal public education, namely, (1) a standard graded course of instruction leading from the kindergarten through the university to the learned, technical, and business professions, and (2) adequate provision for those who can not pursue the whole course or who for any reason whatever have got out of the

direct line of the standard course. It is mainly to fulfill this second function that special agricultural schools have been established. The influence of such schools and their place in a system of public education were summarized as follows:

(1) To stimulate the general introduction of agriculture into the ordinary high schools and in a general way to set the pace for and give permanence to secondary education in agriculture.

(2) To aid in the preparation of teachers for the rural schools. This is accomplished in a definite way in Wisconsin by connecting teachers' training schools with the county schools of agriculture.

(3) To serve as vocational connecting schools between the public elementary schools and the agricultural colleges. In order to do this effectively, the standard courses of study for these schools should conform in a general way to that of the ordinary public high schools of the State. These courses should include instruction in English, history, mathematics, chemistry, and botany, such as is generally given in good high schools.

(4) To serve as schools to which boys who have chosen to become farmers may elect to go for more thorough and effective preparation for their life work than the ordinary public high schools can give.

(5) To relieve the agricultural colleges of much of the secondary and short-course work they are now compelled to do, to the detriment in many cases of their regular collegiate work and that of research in agriculture.

(6) To serve the farming communities more intimately and sympathetically than the agricultural colleges can do and more effectively than the public high schools can do. This they can accomplish (*a*) by conducting short courses for adult farmers at points remote from the agricultural colleges; (*b*) by extension teaching in different parts of their respective districts; (*c*) by rendering the farmers expert assistance and advice; (*d*) by conducting demonstration experiments on their own farms and on those of leading farmers in their districts; and (*e*) by conferring with teachers in near-by public schools and assisting them in planning and conducting agricultural work.

(7) To be most effective, these special agricultural schools should be so limited in number that they will serve relatively large districts—10 or 15 counties, depending upon the density of the rural population, the value of farm lands, and other local conditions. Experience thus far has shown that the county is too small a unit for the proper equipment and maintenance of such schools and too small to supply a sufficient number of students. These schools should be large enough and have funds enough to maintain a relatively large faculty and an adequate modern equipment, so that their students will not only have offered to them a standard course of high-school grade, but will also have opportunity to specialize to some extent along different agricultural lines.

(8) The courses in agriculture in the different schools may well be varied according to the predominant agricultural industries in different regions, and there should also be short practical courses for those who can not complete the standard course.

(9) Agricultural high schools, whether connected with colleges or maintained separately, should be kept strictly secondary in grade and there should be no pretense of giving collegiate instruction in such schools.

An address on How the Schools and the United States Department of Agriculture can Cooperate was given by W. M. Hays, Assistant Secretary of Agriculture. Prof. Hays sketched briefly the recent de-

velopments in rural education, including the movement for the abandonment of numerous small district schools and the establishment of centralized schools, and then described in a few words the work of the different bureaus and offices of this department, particularly with reference to the publications they are issuing which are used or may be used in the public schools in connection with the teaching of agriculture and home economics. He also emphasized the need of cooperation between the State agricultural and mechanical colleges and the State normal schools in preparing teachers for country life education.

There were numerous other papers in which some incidental reference was made to instruction in agriculture. At the joint session of the departments of agriculture, secondary education, and science a number of papers were given dealing with the practical aspects of science in secondary education, with special reference to the introduction of materials from agriculture, household arts, and technical industries. W. R. Hart, of Massachusetts, read a paper giving the pedagogical viewpoint in which he brought out particularly the splendid opportunities for correlation between the various science subjects and agriculture. The scientific viewpoint was discussed by W. J. V. Osterhaut, physics by William Orr, chemistry by J. S. Mills, zoology by C. A. Mathewson, and physiology and hygiene by Louis Murbach.

At this session a report of the committee on encouraging college entrance credit in high-school agriculture was given by A. B. Graham. This report showed that the difficulties to be encountered in giving college entrance credit for high-school agriculture are the determination of what should constitute a unit or half unit, and the quality of the teaching of agriculture. The report contained the statement that "Few, if any, colleges or universities have been found that are willing to give any credit on the science of agriculture if such agriculture as taught is only some application of general science." The unit and half-unit definitions adopted by the committee were as follows:

One-half unit.—One half year given to the study of soils and plants and their relation to each other. There shall be sufficient experimental work to accompany the subjects discussed.

One unit.—One full year given to the study of soils, plants, insects, and farm animals. There shall be sufficient experimental and demonstration work to be equivalent to one full year of laboratory work.

The committee had made an investigation of the institutions with reference to their attitude on the matter of giving credit for high-school agriculture, and gave a list of 36 colleges now giving such credit. These included 7 State universities which do not have colleges of agriculture, 5 State universities having colleges of agriculture, 5 separate agricultural and mechanical colleges, and 19 other colleges and universities. The lists given by the committee also contained the names of 23 colleges giving no credit, including, however,

11 that seem to be willing to give credit, 8 colleges preparing to give credit, and 27 colleges that would give credit if asked to do so or that are willing to give credit for work properly done. This report is given in full in the proceedings of the National Education Association and will be of very great value to those interested in the progress of agricultural education.

The department of normal schools gave incidental consideration to the subject of agriculture in a session devoted to papers on the special preparation of teachers for the rural schools, the training of teachers for industrial and vocational work, and a report on agricultural work in normal schools.

A report on The United States Government Materials that are Usable in Secondary Education was given by W. N. Clifford at one of the meetings of the department of science instruction. This report was devoted mainly to a discussion of the publications of this department suitable for use in secondary schools in connection with science instruction and instruction in agriculture.

Several of the societies meeting with the National Education Association held sessions devoted wholly or partly to the discussion of problems in agricultural education. The National Committee on Agricultural Education held one such session at which the problem of national aid for industrial education was discussed. A conference of teachers of agriculture was held for the purpose of discussing some of the problems of these teachers and the advisability of forming a national association of teachers of agriculture.

The American Home Economics Association held two important sessions devoted to the discussion of the Presentation of Subject Matter in Household Science and Art to Elementary Pupils, and Methods of Teaching Household Science and Art in Secondary Schools. Teachers of these subjects were present from all parts of the country to take part in these discussions. One of the principal addresses at the last general session of the National Education Association was also on this subject. Mrs. W. N. Hutt spoke on the Education of Women for Home Making.

THE GRADUATE SCHOOL OF AGRICULTURE.

The prospectus of the Graduate School of Agriculture, issued just before the close of the year, announced that the fourth session of the school would be held at the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, July 4-29, under the auspices of the Association of American Agricultural Colleges and Experiment Stations. Some notion of the character and extent of this enterprise can be had from the following excerpts from the prospectus:

PURPOSE OF THE SCHOOL.

The purpose of the Graduate School of Agriculture is to give advanced instruction in the science of agriculture, with special reference to the methods of investigating agricultural problems and teaching agricultural subjects.

EQUIPMENT OF COLLEGE DEPARTMENTS.

AGRICULTURAL ENGINEERING DEPARTMENT.

The agricultural engineering department occupies the ground and first floors in agricultural engineering hall and practically all of agricultural engineering annex. The latter is a fireproof building erected at a cost of about \$70,000 expressly for the purpose for which it is used.

The farm machinery laboratories contain a large and quite complete assortment of samples of modern implements, farm machines, and farm motors. This laboratory has many special instruments such as traction, transmission, and absorption dynamometers, indicators, and testing machines.

The tool room, besides the miscellaneous tools and instruments of the department, contains a sufficient number of surveying instruments to equip 14 parties for field engineering.

Well-equipped forge and carpenter shops are provided as well as convenient drawing rooms, classrooms, and offices.

AGRONOMY DEPARTMENT.

Soils.—Seven new laboratories with modern equipment are devoted exclusively to the work in soils. The soil bacteriology laboratories are of unusual interest. Ample greenhouses and 25 acres in experimental plats afford special advantages for the seminar work in soils. Seven distinct soil types are found on the college farm and two soil series.

Farm crops.—Several hundred field plats, devoted to breeding and experimental work in farm crops, will be available for the graduate school students. Many of these plats will be of special value to those who are interested in plant breeding. The large and well-equipped laboratories which are used for instruction in farm crops are modern in every way and should offer many helpful suggestions to those who are in charge of the installation of laboratories for the use of students in crop production.

ANIMAL HUSBANDRY DEPARTMENT.

The herds and flocks consist of excellent representatives of 31 distinct breeds, thus giving equipment for live-stock work not excelled by any other institution.

The horse equipment consists of eight breeds: Imported and home-bred Shires, Clydesdales, Percherons, Belgians, Hackneys, and French Coach; also Standard Bred and American Saddle Horses.

More than 200 head of cattle, forming complete herds of the leading beef, dual purpose, and dairy breeds are maintained; as well as a large number of pure and crossbred show steers and feeding cattle.

In the flocks of sheep of over 200 head will be found the best representatives of nine different breeds.

In hogs, represented by the best American and British varieties, the breeding herds have been especially well selected.

On the poultry farm will be found 1,000 birds consisting of the leading American, Asiatic, Mediterranean, and English breeds.

To further strengthen the live-stock equipment preparations have been made for the use of some of the best imported animals of the several breeds.

BOTANY DEPARTMENT.

The botanical department occupies the top floor of the central building. The special laboratories devoted to morphology, mycology, and economic botany are well equipped with microscopes, and various accessories, as well as special apparatus such as sterilizers, and equipment for culture work to carry on work in special lines of botany. Each student is provided with an individual laboratory table, microscope, and reagents. There is also a complete line of preserved material, a large collection of mounted microscopic slides, a large collection of fungi, and a general herbarium of 70,000 specimens, containing the more important weeds and poisonous plants of the United States as well as a very representative collection of economic grasses.

DAIRY DEPARTMENT.

The dairy department is fully equipped to give excellent demonstration work in its creamery, testing laboratory, farm dairy room, and ice-cream laboratory.

ECONOMICS DEPARTMENT.

For the work in rural economics the college library affords ample opportunity for reference work in connection with the lectures given.

DEPARTMENT OF HORTICULTURE AND FORESTRY.

The department of horticulture and forestry has commodious quarters in the new hall of agriculture, also a separate laboratory building and about 10,000 square feet of glass. On the campus, which covers about 90 acres, is found an interesting collection of native and exotic trees and shrubs. The field area of the department amounts to about 90 acres more, which includes various orchards and other fruit plantations, the nurseries, fruiticetum, vegetable garden, and Upper Mississippi Valley plant introduction garden. This garden includes specimens of various species of the apple, crab apple, and pear; also a few walnuts, apricots, persimmons, elms, poplars, hydrangeas, hawthorn, roses, and some other species of minor importance.

In apple breeding a study of heredity is being made, which includes investigations as to what characters in the apple are unit characters and which of them are Mendelian. The station orchards and nurseries now include practically all the hardiest valuable cultivated varieties of the apple known to American horticulture, together with the leading amateur and commercial sorts which can be fruited in Iowa; also representatives of the native and many exotic species with many of their hybrids. They contain over 10,000 apple seedlings, most of which are of known parentage and some are of the second generation with known parentage, a rare occurrence among apples.

One entire orchard exhibits an interesting experiment in top-working less hardy commercial varieties of superior fruit upon selected hardy stocks.

Fine opportunities are afforded for the study of ornamentals. The campus contains over 100 species of trees and most of the shrubs which are hardy are found in the fruiticetum or on the campus.

REQUIREMENTS FOR ADMISSION.

Only persons who have completed a college course and taken a bachelor's degree will be admitted to the privileges of the school, except that admission may be granted to nongraduates who are recommended by the faculties of the college with which they are associated as persons properly qualified to profit by advanced instruction in agriculture.

COURSES OF STUDY.

Instruction will be given in eight main lines—plant physiology and pathology, agronomy, horticulture, animal husbandry, poultry, dairying, rural engineering, and rural economics and sociology.

The Saturday morning periods and Wednesday and Friday evenings will be devoted to conferences on topics of general interest relating to agricultural education. There will also be social assemblies and visits to prominent agricultural establishments.

A Graduate School of Home Economics under the auspices of a committee of the American Home Economics Association will also be held in Ames during July, 1910.

CONFERENCES.

Since extension departments are now being widely organized in the agricultural colleges, it is proposed to devote considerable time at this session of the graduate school to a discussion of the functions and organization of such departments, their relation to the experiment stations and teaching departments, etc. It is believed that this will be of general interest to all members of the school, and therefore two evenings of the second and third weeks of the session and one Saturday forenoon will be devoted to the problems of extension work.

Leaders in this movement from different parts of the country will be invited to open the discussions.

General topics, such as agriculture in secondary schools, agricultural journalism, and conservation of our national resources will be presented at evening and Saturday conferences. Excursions to typical Iowa farms will be arranged for.

FACULTY.

Alfred Charles True, Ph. D., Sc. D., Dean.

William H. Pew, B. S. A., Registrar.

INSTRUCTORS IN PLANT PHYSIOLOGY AND PATHOLOGY.

Plant physiology.—E. von Tschermak, Ph. D., professor of plant breeding in the Royal Imperial Agricultural College, Austria; D. T. Macdougall, Ph. D., director of the department of botanical research, Carnegie Institution; H. J. Webber, M. A., Ph. D., expert in plant breeding, Cornell University; C. E. Bessey, Ph. D., LL. D., head dean and head division of botany, University of Nebraska.

Plant pathology.—E. F. Smith, Ph. D., pathologist in charge of laboratory of plant pathology, United States Bureau of Plant Industry; L. H. Pammel, B. Agr., M. S., Ph. D., professor of botany, Iowa State College; F. L. Stevens, Ph. D., professor of botany and vegetable pathology, North Carolina College of Agriculture and Mechanic Arts.

INSTRUCTORS IN AGRONOMY.

Soil bacteriology.—J. G. Lipman, Ph. D., associate professor of agriculture, New Jersey College of Agriculture and Mechanic Arts.

Soils.—W. H. Stevenson, A. B., B. S. A., professor of soils, Iowa State College; S. L. Jodidi, Ph. D., experimentalist in soils, Iowa Experiment Station.

Soil and crop improvement.—C. G. Hopkins, Ph. D., chief division of agronomy, University of Illinois; L. H. Smith, Ph. D., assistant professor of plant breeding, University of Illinois.

Experimental methods with crops.—C. V. Piper, M. S., agrostologist in charge of forage crop investigations, United States Bureau of Plant Industry.

INSTRUCTORS IN HORTICULTURE.

Pomology.—U. P. Hedrick, M. S., horticulturist, New York Agricultural Experiment Station; J. C. Whitten, Ph. D., professor of horticulture, University of Missouri; S. A. Beach, B. S. A., M. S., vice dean, division of agriculture, and professor of horticulture, Iowa State College.

Storage and marketing.—W. A. Taylor, B. S., pomologist in charge of field investigations, United States Bureau of Plant Industry; G. H. Powell, M. S. Agr., pomologist in charge of field investigations, United States Bureau of Plant Industry.

Landscape architecture.—J. S. Pray, A. B., professor of landscape architecture, Harvard University.

INSTRUCTORS IN ANIMAL HUSBANDRY.

Principles of breeding.—W. E. Castle, Ph. D., professor of zoology, Harvard University; J. C. Ewart, M. D., professor of natural history, University of Edinburgh, Scotland.

History of breeds.—E. W. Morse, B. A. S., associate editor of zootechny, Experiment Station Record, United States Office of Experiment Stations.

Principles of nutrition.—H. P. Armsby, Ph. D., LL. D., director of Institute of Animal Nutrition, Pennsylvania State College.

Beef cattle.—C. F. Curtiss, M. S. A., Sc., D., dean, division of agriculture, Iowa State College; W. J. Kennedy, B. S. A., professor of animal husbandry, Iowa State College; H. J. Waters, B. S. A., president of Kansas State Agricultural College.

Dairy cattle.—C. H. Eckles, B. Agr., M. S., professor of dairy husbandry, University of Missouri.

Horses.—C. W. Gay, D. V. M., B. S. A., professor of animal husbandry, University of Pennsylvania.

Swine.—G. E. Day, B. S. A., professor of animal husbandry, Ontario Agricultural College.

Sheep.—J. A. Craig, B. S. A., director, Oklahoma Agricultural Experiment Station.

INSTRUCTORS IN POULTRY HUSBANDRY.

Biology.—Raymond Pearl, Ph. D., biologist, Maine Agricultural Experiment Station.

Feeding and management.—J. E. Rice, B. S. Agr., professor of poultry husbandry, Cornell University; James Dryden, professor of poultry husbandry, Oregon Agricultural College.

Diseases.—P. B. Hadley, Ph. D., biologist, Rhode Island Agricultural Experiment Station; G. B. Morse, M. D., Ph. D., assistant in pathology and bacteriology, Pathological Laboratory, United States Bureau of Animal Industry.

INSTRUCTORS IN DAIRYING.

Bacteriology.—C. E. Marshall, Ph. D., professor of bacteriology and hygiene, Michigan Agricultural College.

Cheese making.—J. L. Sammis, Ph. D., assistant professor of dairy husbandry, University of Wisconsin.

Butter and milk (factors influencing keeping qualities).—L. A. Rogers, B. S., and S. H. Ayers, B. S., Dairy Division, United States Bureau of Animal Industry.

Condensed milk.—O. F. Hunziker, M. S. A., professor of dairy husbandry, Purdue University.

Creamery management and ice cream.—M. Mortensen, B. S. A., professor of dairying, Iowa State College.

Organization of dairy schools.—E. H. Farrington, M. S., professor of dairy husbandry, University of Wisconsin.

INSTRUCTORS IN RURAL ENGINEERING.

Agricultural mechanics.—J. B. Davidson, B. S., M. E., professor of agricultural engineering, Iowa State College.

Farm buildings.—F. H. King, former professor of agricultural physics, University of Wisconsin.

Drainage.—C. G. Elliott, chief, drainage investigations, United States Office of Experiment Stations.

Irrigation.—L. G. Carpenter, M. S., professor of civil and irrigation engineering, State Agricultural College of Colorado; S. Fortier, Sc. D., chief, irrigation investigations, United States Office of Experiment Stations.

INSTRUCTORS IN RURAL ECONOMICS AND SOCIOLOGY.

Sociology.—K. L. Butterfield, M. A., president Massachusetts Agricultural College and professor of rural sociology.

Economics.—H. C. Taylor, Ph. D., in charge of department of agricultural economics, University of Wisconsin; B. H. Hibbard, B. Agr., Ph. D., professor of economics and political science, Iowa State College.

Farm management.—W. J. Spillman, M. S., agriculturist, United States Bureau of Plant Industry.

THE AGRICULTURAL COLLEGES.

In 1910 agricultural colleges receiving Federal funds were in operation in all the States and Territories except Alaska. Including the separate institutions for negroes in the South, there were 67 such institutions. In addition to these there were 4 forest schools offering collegiate or graduate work, in connection with Colorado College, Yale University, Harvard University, and the University of Michigan, and 24 privately endowed colleges offering regular courses in agriculture. It was also announced that the trustees of Syracuse University had decided to establish a college of agriculture and forestry, that the College of Idaho, at Caldwell, was to enlarge its faculty and extend its courses so as to include work in theoretical agriculture, and that Columbia University had received \$15,000 for agricultural education. The last institution conducted a course of popular lectures on agriculture during the winter. In most cases

the agricultural work of the privately endowed colleges was popular in nature or of secondary grade, so it might more properly be included under the discussion of secondary schools.

Under a new State law in Mississippi a single board of trustees has been appointed for the Mississippi Agricultural and Mechanical College, the Alcorn Agricultural and Mechanical College (for negroes), the University of Mississippi, and the Industrial Institute and College (for women). This board took charge July 1, 1910.

The Legislature of Oregon has passed a law under which a board of five members, to be known as the board of higher curricula, is to be appointed by the governor. The duties of this board are to prevent duplication of studies or departments in the agricultural college and the State University. The board is empowered to determine and define the courses of study to be offered by each institution and the departments to be conducted, and after investigation and 20 days' notice may direct the elimination of any duplicating courses or departments.

By a recent act of the Utah Legislature the number of trustees for the agricultural college has been increased from 7 to 9.

The agricultural colleges surpassed all previous records in the number of students enrolled and in the number studying agriculture. There were 52,250 students enrolled in the interior courses of these institutions, 30,075 in correspondence courses, 21,004 in extension schools, and 32,505 in all other departments—a total, counting none twice, of 135,250 students. Of agricultural students there were 17,375, which is 10 per cent more than there were in 1909; and of students in teachers' courses in agriculture 1,865, more than eight times as many as in 1909. The income of the land-grant institutions was larger by three and one-half millions than in 1909, and they added more than seven millions to their permanent endowment and equipment.

HISTORICAL.

On April 14, 1910, the State of Vermont, at Montpelier, celebrated in a dignified manner, yet with the simplicity well suited to the man and the occasion, the hundredth anniversary of the birth of Justin Smith Morrill, whose death occurred on December 28, 1898. The audience included many of State-wide and national fame who came to do honor to the memory of this statesman.

This succinct statement is taken from a memorial volume containing the addresses delivered on the occasion of the centenary exercises in honor of the author of the land-grant act of 1862 and the second Morrill Act of 1890. The principal eulogy was delivered by President Matthew H. Buckham, of the University of Vermont, who dwelt especially on Senator Morrill's work in connection with the founding and endowment of the land-grant colleges, characterizing

this as the last and greatest of his public measures. There were also addresses by Gov. George H. Prouty, Senator William P. Dillingham, Col. William M. Hatch, Col. Curtis S. Emery, and Hon. Horace W. Bailey. These addresses are given in full in the memorial volume, together with brief tributes from President Taft, Senators Cullom, Gallinger, Aldrich, Lodge, and Frye, ex-Senators Edmunds and Chandler, Rear Admiral Clark, and Strafford Grange.

The twenty-fifth anniversary of the establishment of the Oregon Agricultural College was celebrated at the college June 10-18, 1910.

Idaho University plans to hold an annual recognition day, the purpose of which will be to give official recognition to men who have been prominent in the development of the State and the promotion of its interests. It is expected that the list will include many who have promoted the development of irrigation, live stock, fruit growing, and other agricultural enterprises, and also many prominent in educational circles. The ceremony will take place each year as a part of the commencement exercises.

A farmers' hall of fame has been established in the college of agriculture of the University of Illinois "to record the services and commemorate the lives of the great leaders of the State in the development of agriculture from a pioneer art to a civilized science, on which the prosperity of all classes will ultimately depend." The selection of names rests with a commission, which thus far has chosen four men: Cyrus Hall McCormick, inventor of the reaper; James N. Brown, first president of the State board of agriculture; Isaac Funk, a successful and influential pioneer farmer; and Prof. Jonathan B. Turner, an early advocate of the land-grant plan for the support of industrial education. Exercises were held December 15, 1909, installing the name of Mr. McCormick in the hall of fame. The ceremonies included the unveiling of a portrait and addresses by Gov. Deneen, President Grout, of the commission, Dean Davenport, and others.

Dr. J. K. Patterson, for many years president of the Kentucky Agricultural and Mechanical College (now the State University), retired from active service and was succeeded January 1, 1911, by Judge Henry S. Barker, chief justice of the State court of appeals.

APPROPRIATIONS.

There is a growing tendency on the part of State legislatures to provide fixed tax levies for the support of institutions of learning. This method has obvious advantages in that it enables those in charge of the institutions to plan far in advance, with reasonable assurance that the funds necessary to fulfill their plans will be available. In California the legislature has increased the rate of taxation for the support of the university from 2 to 3 cents on each \$100 of assessed

valuation. This provides an income for the current year of about \$550,000. Appropriations were also made aggregating \$130,000 for additional buildings and equipment at the university farm at Davis, and \$88,500 for its maintenance during the ensuing biennium; \$20,000 for farmers' institutes; \$15,000 for viticultural investigations; \$12,000 for cereal investigations; and about \$40,000 for the equipment and maintenance of the Southern California Pathological Laboratory at Whittier.

In Connecticut the total State appropriations for the agricultural college during the biennium aggregated \$112,101. Of this, \$50,000 was for current expenses, \$4,000 for the station, \$18,000 for four new cottages, \$12,500 for a dining hall, \$10,000 for the improvement of the road from the college to the railroad station, \$8,500 for the purchase of an additional farm, \$5,000 for the equipment of the horticultural hall, and the remainder for miscellaneous improvements.

Georgia State College of Agriculture has an appropriation of \$125,000 for maintenance during the biennium. Of this sum, \$10,000 is for extension teaching, which, with funds available from other sources, will supply about \$14,000 a year for this purpose.

In Massachusetts the legislature of 1910 appropriated \$142,000 for maintenance and \$115,625 for additions to equipment and other special purposes for 1911. This is an increase in income of \$37,500, of which \$30,000 is for general instruction and maintenance and \$7,500 for short courses.

The appropriations by the Minnesota Legislature for the college and school of agriculture included \$50,000 for a girls' dormitory, \$30,000 for dairy structures and equipment, \$10,000 for a poultry department, \$43,400 for minor studies and equipment, \$82,000 for maintenance and buildings at the Crookston School of Agriculture, \$11,500 for the Crookston substation, \$14,000 for the Grand Rapids substation, and \$50,000 for extension work in agriculture during the ensuing biennium.

The Legislature of New York in 1910 gave the college of agriculture an increase of \$25,000 for maintenance and of \$2,000 for extension work, together with \$113,000 for a classroom and auditorium building, \$90,000 for a poultry building, and \$154,000 for a home-economics building. A significant feature of the legislation is the practical acceptance by the legislature of a systematic plan of development for the college as outlined by the board of trustees. This plan looks toward the growth of the institution during the next 10 years, and if carried out will necessitate the expenditure of nearly \$2,000,000 for buildings and equipment.

In North Carolina the legislature gave the Agricultural and Mechanical College, at Raleigh, an annual appropriation of \$70,000 for maintenance and \$18,000 annually for the ensuing biennium for



FIG. 1.—MILLBANK AGRICULTURAL HALL, TUSKEGEE INSTITUTE.

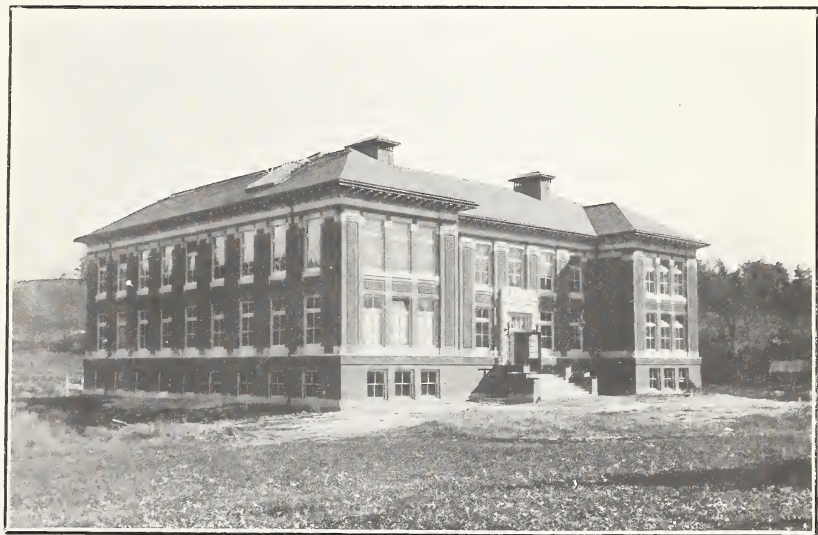


FIG. 2.—LABORATORY FOR ZOOLOGY AND ENTOMOLOGY, MASSACHUSETTS COLLEGE.



FIG. 1.—HADLEY HALL, THE ADMINISTRATION BUILDING AT THE NEW MEXICO COLLEGE.



FIG. 2.—WILSON HALL, THE NEW MEXICO AGRICULTURAL BUILDING.



FIG. 1.—BOYS' DORMITORY, NEW MEXICO COLLEGE.



FIG. 2.—Y. M. C. A. BUILDING, NEW MEXICO COLLEGE.



FIG. 1.—CERES HALL, THE WOMEN'S BUILDING, NORTH DAKOTA COLLEGE.



FIG. 2.—VETERINARY LABORATORY, NORTH DAKOTA COLLEGE.

permanent improvements and equipment. The Agricultural and Mechanical College for the Colored Race, at Greensboro, was granted an annual appropriation of \$10,000, together with \$4,350 annually for the ensuing biennium for repairs, improvements, and sewerage.

The last Legislature of Oregon appropriated for the ensuing biennium a total of \$210,000 for the agricultural college. Of this \$60,000 is for additional equipment, \$35,000 for a central heating plant, \$55,000 for an agricultural building, \$35,000 for a drill hall, \$5,000 for greenhouses, and \$20,000 for the purchase of additional land. The annual appropriation for maintenance was also increased to \$80,000.

BUILDINGS.

New buildings have been completed and appropriately dedicated by a number of the agricultural colleges. At Tuskegee Institute a new agricultural building, Millbank Hall (Pl. XII, fig. 1), has been completed. This is a gift from Mrs. Elizabeth M. Anderson, of New York City, and was dedicated February 23, 1910.

The departments of zoology and entomology at the Massachusetts Agricultural College now occupy a new \$80,000 fireproof laboratory building (Pl. XII, fig. 2).

The New Mexico college has recently erected quite a number of new buildings, among them an administration building, which, together with a group of farmers who visited the college on "demonstration day," is shown in Plate XIII, figure 1, an agricultural building known as Wilson Hall (Pl. XIII, fig. 2), a boys' dormitory (Pl. XV, fig. 1), and a Y. M. C. A. building (Pl. XIV, fig. 2)

At the North Dakota college two new buildings have been completed, a home-economics building known as Ceres Hall (Pl. XV, fig. 1), and a veterinary building (Pl. XV, fig. 2). The latter is so constructed as to form essentially three separate structures, the dissecting room and the hospital being connected with the main portion by inclosing corridors. The interiors are very largely of metal and concrete, and the dissecting room is so arranged as to admit light from all directions. A special feature is the killing room, which is equipped with all the appliances of a modern slaughterhouse.

The Indiana college has completed a farm-mechanics building, a brick structure, stone trimmed, 70 by 130 feet. It contains two laboratories each 57 feet square, one of which will be used for heavy machinery and the other for light machinery. There are also two large classrooms, a drafting room, offices, a cement laboratory, tool and supply rooms, and miscellaneous laboratories.

A new agricultural building for the Oregon college and a building for civil and irrigation engineering at the Colorado college are in process of construction.

WORK OF THE COLLEGES.

Progress was made in the more complete and thorough organization of the universities and colleges into colleges and departments. The agricultural work of the University of Arkansas was reorganized into ten departments, as follows: Entomology, horticulture, dairy husbandry, veterinary science, agricultural education, agricultural chemistry, agronomy, plant pathology, animal husbandry, and farmers' institutes. The Agricultural College of Utah was organized into schools of agriculture, domestic science, commerce, and mechanic arts.

Increased entrance requirements went into effect in Kansas, where 8 units of high-school work are now required and the subfreshman work has been organized into a distinct department with added industrial work, including agriculture and shopwork for boys and domestic science and art for girls; in Massachusetts, where 14 Carnegie units are now required; in Porto Rico, where the entrance requirement was raised from the sixth to the eighth grade; and in Rhode Island, where 13 Carnegie units are required in 1910 and 14 will be required in 1911. Rhode Island has abolished preparatory courses and West Virginia has abolished one year of its preparatory course.

At the New Mexico College of Agriculture and Mechanic Arts the college courses in all subjects were raised one full year, thereby bringing them up to the standard college requirements. Four-year industrial courses of high-school grade in agriculture, mechanic arts, domestic science, and business methods were also introduced, these articulating with similar college courses.

The reorganization of college courses has taken place in a number of institutions. In Colorado the college year was changed from the three-term to the two-semester plan. The first two years in all agricultural courses were made alike, also the first two years in all engineering courses. Ten hours of electives were made available in the junior year and 20 hours in the senior year in all four-year college courses. In Kansas the collegiate courses of study have been entirely recast and more closely articulated with the public-school system of the State. Elective courses in the junior and senior years have been introduced and the opportunity given for a broader range of selections. The student now enters upon the special course which he will pursue at the beginning of the freshman year instead of at the beginning of the sophomore year.

A veterinary college, offering a four-year collegiate course, was established at the Michigan Agricultural College, with Dr. R. P. Lyman as dean. Departments of home economics were established in connection with the State universities in West Virginia and Wisconsin. Among other new courses introduced were industrial jour-

nalism, milling industry, forestry and highway engineering in Kansas, farm drainage in Maryland (Princess Anne Academy), rural engineering in Mississippi, a four-year general science course in New Jersey, and landscape gardening in Pennsylvania. In Washington a four-year collegiate course in forestry was added and the two-year forestry course was reduced to one year of purely technical work.

At a conference of forest schools held in Washington, D. C., December 30-31, 1909, a committee consisting of H. S. Graves, B. E. Fernow, Filibert Roth, R. T. Fisher, and Gifford Pinchot reported to the conference a plan for establishing a minimum standard curriculum in forestry and looking toward the permanent organization of a forest conference. This report was adopted and the committee continued, with power to call a meeting of such a conference and to formulate a constitution for the proposed association, and, in consultation with the Forest Service and other employers of foresters, to prepare a standard of forest education.

The agricultural colleges have frequently been criticized for not sending more of their graduates back to the farms. These criticisms have come from those who do not take into consideration the fact that many of these graduates who take up work in the agricultural colleges and experiment stations are exerting a wider influence for the advancement of agriculture than they could as farmers. However that may be, it seems from recent investigation of the matter on the part of a few of the colleges that a very large percentage of the graduates of the larger, better equipped agricultural colleges actually return almost immediately to the farms. As an indication of this, 30 of the 38 graduates of the animal-husbandry course in Iowa State College will engage in farming, 4 will teach in agricultural colleges, and 1 will go into agricultural journalism. Only 3 of these graduates were looking for positions at commencement time and these wanted to become farm managers. Out of 189 recent graduates of the same institution who are engaged in agriculture, 132 are farmers. According to a recent compilation as to the pursuits followed by the alumni of the Illinois College of Agriculture during the past ten years, 115 of the total 184 graduates are engaged in farming, 40 are connected with the agricultural colleges and experiment stations, 7 are with the United States Department of Agriculture, and another is an agricultural editor, making about 90 per cent connected with the agricultural industry.

COURSES FOR TEACHERS.

At least 46 of the agricultural colleges maintained teacher-training courses in agriculture, and these courses varied from summer courses of a few weeks to regular four-year courses with additional graduate work. Four-year courses for teachers are offered by 22 colleges, in-

cluding colleges for whites in Idaho, Illinois, Indiana, Louisiana, Maine, Massachusetts, Mississippi, Missouri, Nebraska, North Dakota, Oklahoma, Oregon, Rhode Island, Vermont, Washington, West Virginia, and Wisconsin, and schools for negroes in Alabama, Maryland, Missouri, South Carolina, and Texas. Three-year courses were offered by the Arkansas, Florida, and North Dakota agricultural colleges, and by the schools for negroes in Georgia, Louisiana, and Virginia. The agricultural colleges for whites in Idaho, Minnesota, Mississippi, New York, North Carolina, and Texas, and for negroes in Florida, Mississippi, and Oklahoma give two-year courses, and the colleges for whites in Maine, Michigan, Nebraska, North Carolina, and West Virginia, and for negroes in North Carolina offer one-year courses for teachers of agriculture. The Alabama Agricultural College offers 15 electives intended especially for teachers.

Twenty-nine of the colleges provide summer schools of agriculture for teachers,¹ five (Connecticut, Massachusetts, Missouri, Pennsylvania, and Utah) cooperate with other agencies, and seven (Florida, both white and negro schools, Kansas, Massachusetts, Oklahoma, Pennsylvania, and South Dakota) conduct correspondence courses for teachers. Two courses in agricultural education were conducted during the summer quarter of the University of Chicago.

Quite a number of the agricultural colleges established departments of agricultural education or appointed professors of agricultural education. In Alabama L. N. Duncan was transferred from the assistant professorship of agriculture to the professorship of agricultural school work.

In California a division of agricultural education was organized, in which Leroy Anderson, professor of dairying and superintendent of the university farm schools, was given direct charge of secondary instruction in agriculture, and E. B. Babcock was appointed assistant professor of agricultural education to aid in the secondary instruction and have direct charge of elementary instruction in agriculture, the introduction of garden work, and the organization of agricultural clubs. Four new courses are offered for regular and special students in the university on teaching agriculture in high schools, teaching agriculture and nature study in the elementary schools, gardening for prospective teachers, and a special course for students who are preparing to teach the sciences and desire to obtain some preparation in horticulture and agriculture.

Delaware college gave some attention to preparing teachers for the teaching of agricultural subjects in the schools of the State.

¹ Summer schools for teachers are held at the colleges in California, Connecticut, Georgia, Illinois, Kansas, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New York, North Carolina (both white and negro schools), North Dakota, Ohio, Oklahoma, Oregon, Rhode Island, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia (colored), Washington, West Virginia, and Wisconsin.

As a result of the marked success of its correspondence course for teachers, instituted last year, the University of Florida has extended these courses to farmers and their families and others who may be interested. The new courses ran from November 1 to June 1, 1910. The subjects covered included elementary agriculture, soils, tillage, drainage and irrigation, manures and fertilizers, field crops, types and breeds of live stock, dairy husbandry, animal breeding, feeds and feeding, and citrus fruits and citrus culture. There is no age limit or entrance examination in these courses, and the only expense incurred is for postage and the textbook. There were about 500 students in the correspondence courses, including 200 in the teachers' courses.

An assistant in charge of school extension was appointed in the Georgia State College of Agriculture. Extension schools for teachers were held at several points in the State in cooperation with the county school commissioners. The staff of the extension department took charge of these institutions and organized work along lines which would enable the teachers to acquire the information necessary to introduce instruction in agriculture into the common schools.

E. L. Holton, a graduate student at Teachers' College, Columbia University, was appointed professor of industrial education for the extension department to have charge of the introduction of agriculture, shopwork, and home economics into the public-school system of the State and supervise the corn contests, boys' corn clubs, and the new correspondence courses.

The Legislature of Michigan authorized the Michigan Agricultural College to grant three-year State teachers' certificates to such of its graduates as have completed the regular four-year course in agriculture, together with a course in pedagogics covering at least one-half year of special instruction in that subject. The college has announced a one-year professional course for agricultural teachers, open to graduates of State normal schools in the life-certificate courses and to other graduates of reputable colleges who have had two or more years of experience in teaching. The new course requires the election of at least 75 units of the technical subjects offered in the regular four-year agricultural course. Candidates may thereafter, if they desire, secure the regular bachelor's degree in agriculture by completing the remaining subjects in the agricultural course. It is expected that this teachers' course will attract the attendance of a considerable number of students who need only technical information to become good teachers of agriculture. The legislature also empowered the governor to appoint a commission of not less than five nor more than seven members to make a careful study of the conditions of elementary, industrial, and agricultural education in the State and to present a report setting forth these conditions and making recommendations for a plan

of elementary, industrial, and agricultural training in the public schools.

In Missouri R. H. Emberson was appointed professor of rural education to act as the representative of the college of agriculture in such matters, serving as superintendent of extension work for the rural schools, in cooperation with the State superintendent, the State normal schools, and the various county superintendents. Through this agency the college is endeavoring to suggest textbooks, bulletins, circulars, apparatus, and reports which will serve to acquaint each school with progress throughout the State. It plans to have this kind of extension work explained in all the teachers' institutes, with a view to having it begun soon in at least six or eight schools in each county.

The department of industrial pedagogy, authorized by the board of regents of the Oregon Agricultural College in January, 1908, but held in abeyance through lack of funds, was given concrete form in August, 1909, when E. D. Ressler, for seven years president of the Oregon State Normal School, was appointed professor in charge. The first semester was devoted to instruction in the county institutes and to the general promotion of industrial education in the State. Classes were organized in the second semester in the pedagogy of elementary agriculture, domestic science and art, and the mechanic arts. A summer school of seven weeks for the benefit of public school teachers who desire opportunity to fit themselves to teach the industrial subjects was inaugurated June 20, 1910.

A department of agricultural education was established at Pennsylvania State College to assist in the work of introducing agriculture into the public schools and to take charge of the correspondence courses in the college. In this connection a beginning has been made in outlining reading courses and correspondence courses for teachers. T. I. Mairs, who has had charge of the correspondence courses for several years, is at the head of the new department.

COLLEGE EXTENSION AND SHORT COURSES.

Agricultural extension teaching is undoubtedly one of the most rapidly developing features of college work. In 1905 there were 4 departments of agricultural extension in colleges; in 1910 the number had reached 27. The appropriations for this work are becoming more and more liberal, though still inadequate. In Iowa the amount given was \$32,000; in Kansas, \$26,000; in Minnesota, \$25,000; in New York, \$50,000; in Ohio, \$20,000 (increased to \$50,000 for 1911); and in Wisconsin, \$30,000, with \$20,000 more for farmers' institutes.

Extension work has included a great variety of enterprises. There have been movable schools; work with public school teachers, as indi-

cated on an earlier page; educational trains, trolley cars, and boats; farmers' institutes; boys' and girls' agricultural clubs and other work with school children; correspondence courses; and numerous features of demonstration work, such as road making, silo construction, orchard spraying, milk testing, butter making, and field experiments. A more extended account of this work is given in the report of the farmers' institute specialist, beginning on page 387.

Short courses in great variety were held. Several of the colleges maintained short-course departments and had special funds for this work. Louisiana held its first short course, beginning January 22, and enrolled 5 students.

More than 2,000 negro farmers and their families attended the annual farmers' conference at Tuskegee Institute in January. In connection with the conference a meeting of agricultural workers in the various negro colleges and schools was held for the purpose of forming a permanent association of such workers to consider methods of instruction in agriculture and related topics. The program consisted of papers and addresses on the management of school farms, organization of departments of agriculture in negro schools, experimental work on school farms, agricultural extension work, how to encourage students to take agricultural courses, and the training of teachers of agriculture.

The first winter conference to be offered by the Florida Agricultural and Mechanical College for Negroes was held at Tallahassee in January, with a large attendance.

The Jewish Agricultural and Industrial Aid Society established 12 scholarships for sons and daughters of Jewish farmers. These scholarships are open to successful contestants in the writing of short essays in English of not more than 500 words, and provide free tuition in the short winter courses of any State agricultural college, together with all other expenses except railroad fare.

The Wabash Railroad offered to each of the 18 counties in Missouri through which its lines run a scholarship of \$50 in the short winter courses at the Missouri College of Agriculture. The college of agriculture also cooperated with the Frisco lines in holding night schools of agriculture in St. Louis and Kansas City. The attendance at St. Louis was over 1,800, and that at Kansas City over 600. Including these two night schools and three special trains, the faculty of the college of agriculture addressed over 40,000 persons during one month.

In California successful short courses were held at the agricultural school and farm at Davis.

Short courses in cotton grading were held in Georgia and Oklahoma.

Last year the Riverside (Cal.) Young Men's Christian Association tried the experiment of offering a course of lectures for citrus growers, and it was so successful that this year the illustrated lectures will include every phase of the subject, from preparing the young trees for planting to harvesting the crop.

A round-table conference devoted to the special work and problems of agricultural libraries was held at the meeting of the American Library Association at Mackinac Island, Mich., June 30 to July 6, 1910 (see p. 318).

THE COLLEGES AT THE INTERNATIONAL LIVE-STOCK EXPOSITION.

The tenth exhibition of live stock, held in Chicago, November 27 to December 4, amply illustrated how materially the show has raised the standards of breeding, feeding, and judging during the past decade. Judged by the number and quality of the animals exhibited, the sales of pure-bred stock, and the large attendance at the meeting of the Breeders' Association, held during the week, popular interest in pure-bred stock has never been so great. The entries numbered 3,908, filling all the available space, and in most classes the quality of stock was superior to that of previous years. The prizes offered aggregated \$75,000. Nearly all sections of this country were represented, together with numerous exhibits from Canada and other foreign countries, and including for the first time an exhibitor and prize winner from Argentina. The appearance of the stock in the arena was much improved by the novel expedient of dying the arena sawdust green, thereby improving the light and simulating outdoor conditions.

The agricultural colleges and experiment stations fully maintained their position of leadership at the exposition, figuring largely in the prize winnings and in the list of judges. Their entries were especially strong in the fat-stock classes, and in the single bullock show they made a surprising record by winning all the championships. There was the usual large attendance of their students and teachers, 16 institutions being represented, and the Missouri University alone sending 395 men.

In the student-judging contest 7 colleges were represented, Iowa winning with a score of 4,940 out of a possible 5,000, followed by Ontario, Ohio, Kansas, Nebraska, Missouri, and Texas. The Iowa team won first on cattle and hogs, that of Missouri on horses, and that of Ohio on sheep. A comparison of the scores with those of previous years showed that 5 men exceeded the highest previous individual record, and 6 of the 7 teams the highest previous team record.

The largest number of breed entries was in the Shorthorn classes, where there were 295 entries of Shorthorns in the breeding and 48 in

the fat classes. There was a special class for milking Shorthorns, 50 per cent being allowed for beef and 50 for milk production. In the Shorthorn steers the Kansas college took first prize on calves and fifth on 2-year-olds, and Iowa stood second on calves. In the yearling class Minnesota took the first prize, Ohio the fourth. In the Shorthorn Association special, Kansas stood first and Iowa second in the senior calves class, and Missouri won two prizes in the junior calves.

The Angus breed ranked next to the Shorthorn in the number of entries and captured the single-steer championship, the reserve championship, the champion herd, and the champion group, the get of one sire, and also won 7 out of the 10 prizes offered in the dressed-carcass contest. The Galloway types exhibited indicated that much improvement has been made in their quality as a beef breed since their first introduction to this country, and 2 prizes in the slaughter test went to this breed. The Polled Durham entries showed an increase to 52, and the Red Polls were also represented in greater numbers than ever before.

In the fat-stock classes there were a large number of exceptionally good steers. The Kansas college won the grand championship with a pure-bred 2-year-old Angus steer, King Ellsworth, bred in Illinois and exhibited last year at the show, when he weighed 1,400 pounds. He was purchased a year ago by the college and fed a ration of corn, bran, oil meal, and alfalfa hay, increasing his weight to 1,750 pounds. The reserve champion was also owned by the Kansas college. In the Angus-steer contest Kansas won first on 2-year-olds, with Minnesota second, Ohio third, Nebraska fourth, and Purdue fifth, and also first and fifth on yearlings, with Nebraska second, Iowa third, and Minnesota fourth. On calves Minnesota was first, Nebraska second, and Kansas third, the last named also taking the breed championship and that for a pen of three. The colleges also took a large number of prizes in the Galloway-steer classes, and in the Polled Durhams Iowa won first in yearlings, calves, and herd, and second in 2-year-olds.

The grades and crosses were judged from butchers' standards by the championship judge, William Heap, of Manchester, England. The standing of the colleges in these classes was also noteworthy. On 2-year-olds Iowa won second and fourth, Missouri third; senior yearlings, Nebraska first; junior yearlings, Iowa first and third, Ohio fifth; senior calves, Missouri first, Purdue fifth; junior calves, Iowa third and fourth; pen of three, Iowa second and third, Missouri fourth; pen of three, get of one sire, Kansas first, Iowa second.

The value of the car-lot exhibit was much increased by the feeding data which were available. The Shorthorns won the championship in both the fat and feeding cattle classes, and for the first time the

champion load, these being yearlings weighing 1,190 pounds and selling for \$15 per hundredweight. This lot was wintered on a ration of corn on the cob with some bran, a little oil cake, and roughage consisting of clover, alfalfa, and timothy. They were carried through the summer in a 20-acre feed lot, with oil cake as a supplementary feed. Cottonseed meal was tried at one time, but as it was not relished a return to oil cake was made. Six weeks before the show brown sugar was fed, each steer being allowed 1 pound daily, and four weeks prior to shipping they were given a daily ration of oats. The prize car lot of 15 short-fed yearlings were Angus, which made a gain of 5,025 pounds at a cost of \$9.59 per hundredweight. The feed consumed in addition to pasture was stated to have been 360 bushels old corn, 450 bushels new corn, 75 bushels crushed oats, 1 ton oil meal, and 6 tons clover hay. The premium car lot of 2-year-olds were Herefords, which gained 4,900 pounds at a cost of \$9.30 per hundredweight. In addition to pasture they consumed 3,785 pounds snapped corn, 4,599 pounds corn-and-cob meal, 2,095 pounds linseed meal, and 3,335 pounds alfalfa hay. The prize winners in the car-lot feeding cattle were mostly from Colorado.

In the cattle slaughter test 7 out of 10 prizes went to the Angus breed, 2 to the Galloway, and 1 to the Red Polled. The first prize in the class for animals 1 year old and under 2 was won by the University of Nebraska on a grade Angus with a live weight of 1,390 pounds, dressing 65.8 per cent and selling for 14.25 cents per pound. The first and second prizes for animals 2 years old and under 3 were also won by the University of Nebraska, and other prizes in this contest were won by the Iowa college and the Ohio State University.

The display in the fat classes of sheep was of high character and showed a growing interest in mutton sheep in the corn belt. Many prizes were won by the Wisconsin, Wyoming, and Ohio Universities. In the dressed-car carcass contest all the prizes were won by the Wisconsin University except the second prize, which went to the Iowa college. The Southdown was the only breed represented in this test. The first-prize yearling dressed 63.48 per cent of the live weight and sold for 10.25 cents per pound. The first-prize lamb dressed 60.64 per cent live weight and sold for 51 cents per pound. A notable feature of this contest was the uniformity in rating on foot and on the block, the lambs that won first and second in the carcass test having won first and second in the open classes for Southdown lambs. The Wyoming University showed a novelty in a Highland-Cotswold cross. This was cut for inspection, as were the best five sheep in both yearling and lamb classes. The forequarter proved to be too heavy and the percentage of fat to lean far too excessive. The pea-fed lot of yearlings submitted by the Wisconsin University won first, as in the past two years.

After an interval of several years the breeding classes for swine were reestablished this year. Prizes were obtained by the Iowa college and the Ohio State and Purdue Universities. In the dressed-swine contest the prize went to a Poland China, which dressed 87.42 per cent, the Iowa college winning third on a Duroc Jersey that dressed 86.27 per cent. The Ohio State University had the only exhibit of fat, large Yorkshires, and showed three barrows of the curly coated Lincolnshire breed—the first brought to this country. Two of these were slaughtered and dressed 77.8 and 77.11 per cent, respectively. The Iowa Station showed a number of pens of swine that had been used in experimental work which illustrated the effect of feeding different rations.

In the special classes for college and station stock, Kansas won first on 2-year-olds, followed by Iowa, Missouri, and Ohio; and also first on yearlings, with Nebraska second, Iowa third, and Minnesota fourth. On calves Missouri won first and third, with Kansas second, and Iowa fourth; and the championship for a single animal and a pen of five went to Kansas.

One very important influence of the International has been in connection with the agricultural colleges, especially of the central West. These institutions have been conspicuous in the show ring and on the list of judges. Their success in training and supplying expert judges and in feeding animals for exhibition has revealed their practical character and the practical value of their courses.

The International has been a common meeting ground for practical stockmen and the alleged theorists of the agricultural colleges. It has been a potent agency in popularizing the colleges and winning the respect and confidence of practical men. At first practical breeders and feeders were skeptical, and held that the professors of agriculture could theorize but were unable to put their theories into practice. It was time for the professor of agriculture to show what he could do, and he has "made good." He has gone into the open market, bought, bred, fed, and fitted for the show animals that have not only won prizes but championships and grand championships year after year. A leading stock paper, in speaking of the last show, says:

The agricultural college is fairly dominant in the meat-making sections. They practice what they preach. * * * Facing the achievements of the past few years in the International arena, no critic raises a note against the practical ability of the college force in the breeding and feeding of meat-making animals. This fact alone is worth all the International has cost, as it establishes on impregnable foundations an agricultural education as expounded at the land-grant colleges.

That the educational value of the International is appreciated by the colleges is attested by the attendance of both teachers and students

in large numbers. This year delegations of students were sent from at least 16 colleges, Missouri leading the list with 395 men.

The exhibition of live stock, not only at the International but at State shows, has been in the nature of a necessity during a certain stage in the evolution of the agricultural college. But the time has come when it is a debatable question in some of the colleges whether they should not withdraw from prize contests and confine their exhibits, if made at all, to animals shown for educational ends solely, eliminating entirely the competitive feature.

This is a question for each college to decide for itself. In some States it may not be necessary longer to demonstrate the importance of the college to the agricultural community, but in many places such evidence of the practical character of the institution is helpful in winning the cooperation of the farmers, and the exhibits themselves have an educational value. In all cases, however, the spirit of commercialism and shrewd competition should be absent, and the plain effort should be to educate the people by furnishing illustrations of the application of scientific principles to the practical affairs of breeding and feeding.

THE COLLEGES AT THE FOURTH NATIONAL DAIRY SHOW.

The Fourth National Dairy Show was held October 14-24, 1909, at the Auditorium in Milwaukee, Wis. The show was opened by President Taft and Gov. Davidson, of Wisconsin, the former setting the machinery in motion by telegraph, and the latter serving as presiding officer on the opening night. The attendance was exceptionally good throughout, this being attributed in part to the marked local interest in the show, the daily press devoting much attention to the enterprise.

In the way of educational exhibits the show was particularly strong. One of the most noticeable features was a working dairy of 16 grade cows, shown by the Dairy Division of this department. Complete records were posted each day as to the cost of food and net profits for the different animals, as a demonstration of the value of keeping records; and there were comparative trials of different methods of feeding. The Dairy Division also showed photographs of modern dairy equipment, barn plans, and other illustrative material relating especially to the care of milk on the farm and in the home. The University of Wisconsin, the Pennsylvania State College, and the Minnesota Dairy and Food Department also had educational displays. The agricultural colleges and this department contributed numerous speakers to the various conventions held in connection with the show, and in the stock-judging contest. Director Hayward, of the Delaware station, served as judge in the Ayrshire class.

The fourth annual conference of the Official Dairy Instructors' Association was attended by about 40 members, representing all parts of the country. The committee on dairy score cards reported that the card adopted by the association at its last meeting is now in actual use in 128 cities, and that 110 others have the card under consideration. Reports were also given by the standing committees on official testing of dairy cows, relations to the National Dairy Show, courses of instruction, experimental work in milk production and dairy manufactures, standards for dairy products, official methods of testing dairy products, extension work, judging dairy cattle, and cow-test associations.

The intercollegiate students' judging contest of dairy cattle was under the supervision of B. H. Rawl, chief of the dairy division of this department, and was participated in by teams from seven institutions. The \$300 sweepstakes trophy and the trophy for highest individual score were won by students from the University of Nebraska, followed in order by the teams from Cornell, the universities of Missouri and Minnesota, the Iowa and Pennsylvania colleges, and the Ohio State University. The breed trophies were awarded to the Ohio State University team for Ayrshires, to that of Missouri for Dutch Belted cattle, to Minnesota for Guernseys, to Nebraska for Holsteins, and to Cornell for Jerseys.

THE SECONDARY SCHOOLS.

At the close of the fiscal year 1910 there were over 630 secondary schools teaching agriculture. These included 58 agricultural schools and 28 public high schools receiving State aid for agriculture, 432 unaided public and private high schools and academies, 46 secondary schools for negroes, several colleges and schools on private foundations, and correspondence schools, but not the normal schools. Agricultural schools were started in connection with a number of the agricultural colleges, State aid for agriculture in public high schools was inaugurated or increased in several instances, and extension work and short courses were successfully conducted by a number of the high schools.

That agriculture is coming to be recognized as a subject worthy of credit in college and university entrance requirements is indicated in the committee report of the National Education Association, to which reference is made on page 343. The strange thing about this report is that so few of the agricultural colleges, relatively, give entrance credit for high-school agriculture.

RECENT PROGRESS BY STATES.

ARKANSAS.

The four district agricultural schools provided for by the Arkansas Legislature were located as follows: First district, Jonesboro; second district, Russellville; third district, Magnolia; and fourth district, Monticello. The Russellville school will open in the fall of 1910, with A. K. Short, formerly animal husbandman of the Arkansas College and station, in charge as principal.

CALIFORNIA.

The department of agricultural education in the State University has published a circular giving the results of a survey of the present status of agricultural instruction in certain public high schools of the State, and containing also the courses offered in the State Polytechnic School, at San Luis Obispo, and the University Farm School, at Davis, and a suggested four-year course in agriculture adapted to correlation with the first two years of the usual high-school course and to specialized study in the last two years.

A number of substantial buildings have been erected at the university farm school at Davis. Among the more important of these are the dairy building and the judging pavilion erected in 1907, the \$30,000 dormitory (Pl. XVI, fig. 1), and the \$20,000 dairy barn (Pl. XVI, fig. 2), erected in 1908, the \$9,000 veterinary building erected in 1909, and the \$23,000 horticultural building (Pl. XVII, fig. 1), the \$7,500 horse barn (Pl. XVII, fig. 2), and the \$5,500 sheep barn erected in 1910.

COLORADO.

The Colorado Agricultural College established a school of agriculture with a course extending over three years of six months each.

IDAHO.

The board of regents authorized the establishment of a school of practical agriculture with a course of study to extend over three years, and with six months' instruction each year, beginning about October 1. E. J. Iddings, assistant in animal husbandry in the Colorado college, was appointed principal of the school.

ILLINOIS.

New courses in agriculture extending over two and one-half years have been introduced into the academy which serves as a preparatory school to the University of Illinois. In these the first year is given



FIG. 1.—DORMITORY, CALIFORNIA AGRICULTURAL SCHOOL, DAVIS.



FIG. 2.—DAIRY BARN, CALIFORNIA AGRICULTURAL SCHOOL, DAVIS.



FIG. 1.—HORTICULTURAL BUILDING, CALIFORNIA AGRICULTURAL SCHOOL, DAVIS.



FIG. 2.—HORSE BARN, CALIFORNIA AGRICULTURAL SCHOOL, DAVIS.

to a study of field crops and soils, the second to animal husbandry, and the remaining half year to orchard and garden crops. It is planned to make the entire course a demonstration of the feasibility of teaching secondary agriculture in the public schools. It is also expected that these courses will afford a satisfactory means of instructing public-school teachers, who may cover the entire work in one year while also pursuing some studies in the college of agriculture. Half-semester courses in cooking, sewing, and the care and planning of the home are also being offered in the academy in connection with the department of household science of the university.

IOWA.

The public high school at Coin, Iowa, offers four years of agriculture as an elective. Similar opportunities for election are offered to students who prefer Latin, household science, manual training, or commercial subjects to agriculture. Agriculture is taught by the superintendent, J. W. Tavenner, who has arranged the nature-study work in the grades so as to make a good preparation for agriculture in the high school.

The course in agriculture is well planned and is briefly outlined below.

FIRST YEAR.

Farm crops.—Corn, seed corn, oats, wheat, potatoes, sweet potatoes, sorghum, sugar beets.

Legumes.—Alfalfa, red clover, white clover, alsike clover, mammoth clover, cowpeas, soy beans, and vetch.

Grasses.—Kentucky blue grass, timothy, redtop, and orchard grass.

Silos.—Historical, form and construction, cost, selection and culture of silage crops, filling the silo, composition and feeding value of silage.

Weeds.—Identification of the neighborhood weeds by means of seeds, stems, and leaves. Habits of growth and methods of eradication. State ways in which weeds are an injury to the farmer. Name not less than five of the worst weeds, and state why. Classify weeds as to habits of growth. Also as to annuals, biennials, and perennials.

Collect seeds from all weeds, vegetables, fruits, nuts, and flowers in the neighborhood. Put them into envelopes or bottles and label each with date, name of plant, where found, and name of collector.

Problems on yield, on amount of the three principal food elements needed to replace that taken by different crops, on fencing fields of different sizes, on number of bushels of corn in different size cribs or bins, etc.

Soil formation.—Mechanical agencies, the chemical action of air and water, plants and animals as soil formers and improvers, soil materials, light and heavy soils, physical characteristics of soils, moisture relations of soils, heat relation of soils, soil temperature affected by color and drainage, chemical characteristics of soils.

Experiments in the laboratory and on plats to determine the water-holding powers of different soils, experiments to demonstrate the capillary movements of water in soils under different conditions, experiments to show the different

methods of conserving soil moisture, experiments to determine whether compact soils will hold more water than loose soils, experiments to determine how organic matter in the soil affects its water-holding power.

SECOND YEAR.

Horticulture.—The plant; propagation of plants—by means of seeds, by cuttings, by layering, by grafting, by budding, by bulbs, rootstalks, stolons, and corms.

Pruning of common fruit, shade, and ornamental trees of different ages; grafting of apple, peach, pear, etc.; budding peach seedlings. Note how fruits fertilize. The proper way to plant a tree and its subsequent care. Identification of neighborhood trees and shrubs. The most troublesome insect and fungus enemies of fruit and ornamental trees and their destruction by spraying and otherwise. Special work in making and the application of spraying mixtures.

The fruit garden, the vegetable garden, the school garden.

Study of roots, stems, and leaves. The preparation and use of hotbeds, coldframes, and pits.

Fruit growing.—The apple, peach, pear, strawberry, raspberry, blackberry, currant, and gooseberry. Define the terms seedlings, stock, scion, standards, dwarfs, free-stone, etc.

Soil fertility.—Improvement by drainage, tillage, manures, fertilizers, lime, humus, green manuring, legumes, and rotation of crops.

Root tubercles and inoculation, sources of nitrogen, sources of phosphorus, sources of potassium, practical methods of maintaining fertility.

Testing soils for acid conditions, pot experiments in growth of plants by adding the different elements of plant food, also the same on field plats.

Comparisons made of crops grown on fields of different degrees of fertility, also comparative yields of the neighborhood.

Problems based upon the amount of plant food taken out of the soil each year by the different crops given. These problems should also show when to grow shallow or deep rooted crops.

THIRD YEAR.

Animal husbandry.—Cattle—beef breeds, dual-purpose breeds, and dairy breeds.

Milk.—Composition and characteristics. bacteria, how milk becomes impure and methods of prevention, use of the Babcock test, cream separators—care and management, management and delivery of cream, butter making, cheese making, renovated or process butter and how to distinguish same from genuine butter.

Testing of individual cows.—Study feeding practices of the neighborhood. Different cuts of meats—their location in the carcass and value for food.

Horses.—Breeds valuable for speed, draft horses, carriage and coach breeds, ponies, mules.

Sheep.—Short-wooled breeds, middle-wooled breeds, long-wooled breeds.

Swine.—Large breeds, middle breeds, small breeds.

Poultry.—General-purpose breeds, meat or table breeds, egg breeds, ornamental breeds, turkeys, ducks, and geese, guinea fowl, squab raising.

Breeds and characteristics of farm animals to be carried through the year. Identification of breeds, judging market types of live stock, studies of local live-

stock interests, the elements of animal nutrition—protein, carbohydrates, minerals, etc.

Feeding standards and balanced rations.

The common ailments of farm animals—symptoms and methods of prevention or treatment.

FOURTH YEAR.

The farm home, buildings, and surroundings.—Location of buildings, plan of house, cost and construction, modern conveniences. Barns and outbuildings, location, plans, cost and construction, sanitary drainage and sewerage, disinfection, sources and supply of pure water. The lawn, walks, and drives. Selection and planting flowers, shrubs, and trees. Cultural suggestions.

Equipment of houses and barns with heat, light, motor power, water pressure, ventilating and cleaning devices, and other machinery.

Farm mechanics.—Cement construction. Walks, basement, stable floors, and driveways, steps, tanks, small bridges, sewer pipe, drain tile, and reinforcement. Silo construction. Tools and leveling for drives. Location of tile and sewer drains. Construction.

Farm machinery.—A study of the elements of mechanics and of machine designs entering into the construction of all machinery, followed by a special study of motors, including gasoline and steam engines, steam boilers, power transmission, windmills, water wheels, pumps, hydraulic rams, farm machinery for tillage, seeding, harvesting, etc.

Roads.—Macadam, sand-clay, burnt-clay. Methods and cost of construction, management, and care. Road drags.

Beekeeping.—Location, what race to choose, what hive to adopt, management in swarming, how to avoid stings, prevention of swarming, how to obtain surplus honey and wax, wintering, risk and loss through disease and enemies, beneficial effects in pollenization.

Forestry.—Forestry and farm designing. The need of forest planting, a planting plan, trees and methods recommended. Special features about the farmstead. The life of a tree, the life of a forest, enemies of the forest.

Recitations on the history, production, and marketing of cereal crops, potatoes, field beans, forage, and miscellaneous crops.

Recitations on elementary farm accounting, selection and purchase of farms, cost and relative profit of various farm operations and systems of farming.

MAINE.

Under a recent act of the Maine Legislature, which provides that any incorporated academy in the State maintaining a course in manual training, domestic science, or agriculture approved by the State superintendent of schools, shall be entitled to receive annually from the State a sum equal to the amount expended for such instruction up to \$250 for each course, an agricultural high-school course has been adopted in Leavitt Institute at Turner Center, Me. The course extends through four years and includes the ordinary academic subjects in addition to a full line of agricultural instruction of secondary grade. A rather unusual feature of the course as reported is the application of chemistry "to agriculture, the study of soils, plant life, and fertilizers" in the first year.

MARYLAND.

The Legislature of Maryland passed a new high-school law providing State aid for agriculture, home economics, manual training, and business courses in two classes of high schools. In high schools of the first class, with at least 80 high-school pupils and a four-year course of study, the State will give \$400 toward the salary of each of two special teachers, and in high schools of the second class, with at least 35 high-school pupils and a three-year course of study, \$400 toward the salary of one special teacher.

The Agricultural High School of Baltimore County, at Sparks Station (P. O. Philopolis), Md., was opened in the fall of 1909 and has had a successful year. B. H. Crocheron, a graduate of Cornell University, is principal and teacher of agriculture. The school has 7 acres of land and a new granite building, containing five classrooms, two of which can be converted into an auditorium which will seat 300 persons. The basement contains three laboratories and a farm-machinery room. The building has heating, lighting, and water systems.

The school is a consolidated one, comprising what was formerly four schools, and is entirely supported by county funds and local contributions. The pupils come by train, by private conveyance, or in school wagons, of which there were three the first year. There were 50 pupils in the high school the first year and considerably more in the grades. The course of study includes all of the usual high-school subjects except the foreign languages, which are replaced by agriculture, home economics, and manual training.

The work of the school during the year was rather remarkable in the attention given to the instruction of farmers and their wives. A description of this feature of the work is given on page 374.

MICHIGAN.

Under the stimulus afforded by the department of agricultural education at the Michigan Agricultural College the number of public high schools maintaining departments of agriculture is increasing as rapidly as qualified teachers can be provided for the work. The teachers of agriculture in these schools have organized the Society for the Promotion of Agricultural Education in the Public Schools.

MONTANA.

The Billings Polytechnic Institute was opened at Billings, Mont., the first week in October, 1909, occupying temporary quarters pending the completion of seven buildings which are in process of con-

struction. The institute is a secondary school, offering courses related to the industries of the region, among which is a four-year course in agriculture. The officers of the corporation include John D. Losecamp, as president, and Lewis T. Eaton, as educational director.

NEW MEXICO.

The New Mexico College of Agriculture and Mechanic Arts has established four-year industrial courses of high-school grade in agriculture, mechanic arts, home economics, and business methods, each of which articulates with a similar college course. Each course contains six units of technical work and ten units of regular high-school work.

NEW YORK.

A recent New York law authorizes any local school board to establish in connection with a city or village high school or a "union free school" a department or a school of agriculture, mechanic arts, and home making, and directs the State commissioner of education to apportion from the State school moneys to each of these schools or departments the sum of \$500 if one special teacher is employed and \$200 additional for each additional special teacher. The State education department is charged with the administration of this law and has appointed F. W. Howe, formerly in this office, as supervisor of agricultural education.

The same law authorizes the State schools of agriculture at St. Lawrence University, at Alfred University, and at Morrisville to give courses for the training of teachers in agriculture, mechanic arts, and home making, and gives them the same apportionment of State funds that is given to public high schools. Graduates from approved teachers' courses in these State schools of agriculture may receive licenses to teach agriculture, mechanic arts, and home making in the public schools of the State, subject to such rules and regulations as the commissioner of education may prescribe.

The first year at the New York State School of Agriculture at Alfred University was a successful one, with 75 students in attendance. A novel feature of the course of study at this school is the arrangement of its three-year course of study (six months each year) under three heads, viz, for boys, for boys and girls, and for girls. The work under the first and third headings is almost evenly balanced in time units, and among the technical studies common to groups one and two are general agriculture, general and agricultural botany, farm law and accounts, rural sociology, butter, cheese, poultry, plant diseases, general and landscape gardening, and insect pests. Besides English, arithmetic, history, and hygiene, careful

attention is also given to physical culture, music, parliamentary practice, and social life.

At Morrisville the courthouse and other county buildings, which were turned over to the school when the county seat was transferred elsewhere, have been repaired and put in readiness for the opening of the school in October, 1910. These afford ample provisions for the present for classrooms and an auditorium, domestic science work, dairy laboratory, mechanical shops, and principal's residence. Green-houses will be erected near the shops. F. G. Helyar, for four years head of the agricultural department of the Moody School for Boys at Mount Hermon, Mass., has been elected principal of the school.

The Genesee Wesleyan Seminary, at Lima, N. Y., established departments of agriculture and domestic economy in the fall of 1909. This institution is one of the oldest college preparatory schools in western New York, having been established in 1829 and opened in May, 1832. During all of this time it has confined its work almost entirely to classical and Latin scientific courses; but more recently it established an engineering preparatory course, a course in commerce, and a seminary course, and now it is developing courses of instruction more closely related to the lives and interests of the people in its vicinity. The agricultural equipment includes 80 acres of land, about 60 of which is available for gardening, fruit growing, and general agriculture, a small herd of dairy cows, work horses, and poultry. F. E. Robertson, a 1909 graduate of Cornell University, was appointed professor of agriculture.

TEXAS.

Under the stimulus afforded by the new law authorizing the State board of education to duplicate expenditures (\$500 to \$2,000) made by the trustees of any public school for the establishing, equipping, and maintaining of departments of instruction in agriculture, including manual training and domestic economy, many schools are making laboratory and other provisions for the effective teaching of agriculture. As an example of what is being done, an illustration is shown (Pl. XVIII, fig. 1) of the new \$125,000 high-school building at Texarkana, Tex., which is supplied with laboratories and other equipment for teaching agriculture, manual training, and domestic science. Agriculture is required in the seventh grade and is elective in the first and fourth years of the high school.

VERMONT.

Just at the close of the fiscal year announcement was made that a secondary school of agriculture for Vermont boys is to be opened in

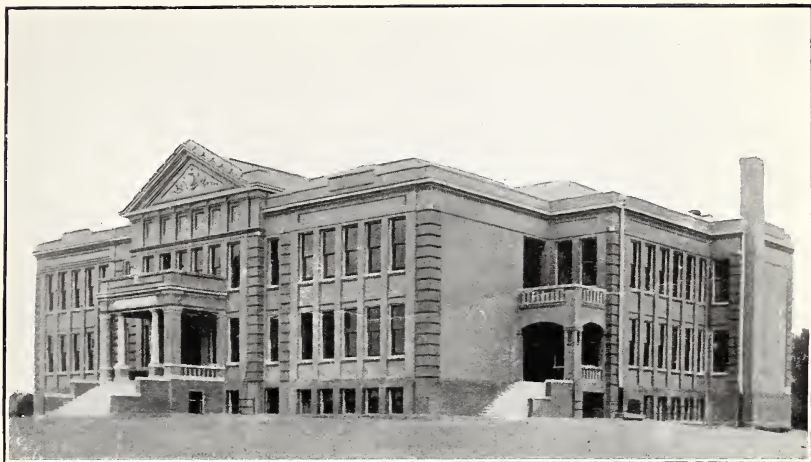


FIG. 1.—AGRICULTURE TAUGHT IN NEW \$125,000 HIGH-SCHOOL BUILDING, TEXARKANA, TEX.



FIG. 2.—ONE OF THE REVIEW CLASSES AT THE GEORGIA STATE NORMAL SCHOOL
MAKING PURITY TEST OF CRIMSON CLOVER SEED.

September, 1910, in connection with Lyndon Institute, Lyndonville, Vt. A two-year course in scientific and practical agriculture will be given, designed to prepare young men for successful farming under Vermont conditions. The course will extend over nine months of each year and will be open to residents of the State eligible for admission to any approved high school.

A unique feature of the school is the provision of two methods by which students may pay their expenses, a cash-payment system and a work-payment system. Boys who choose the latter method will be required to stay at the school throughout the year and will be allowed a maximum of \$25 a month, with board and lodging, during vacation time and 15 cents an hour for work during the school year.

The establishment of the school has been made possible through a gift of Theodore N. Vail, president of the American Telegraph & Telephone Co., who has associated with him as an advisory committee the following persons: Ex-Gov. Fletcher D. Proctor; President John M. Thomas, of Middlebury College; President W. D. Gibbs, of the New Hampshire College; Dean J. L. Hills, of the University of Vermont; State Superintendent of Education Mason S. Stone; and John W. Titcomb, of Lyndonville, Vt. The director of the school will be Arthur W. Merrill, a graduate of the New Hampshire College, and for several years teacher of agriculture at the Baron de Hirsch School.

VIRGINIA.

The State appropriation for agriculture, home economics, and manual training in at least one school in each congressional district has been increased from \$20,000 to \$25,000, and additional funds will subsequently be available for extension and demonstration work.

An organization known as "The Virginia Association of Agricultural Schools" was effected at Richmond, November 24, 1909, of those interested in the development of agriculture in these schools. Director S. W. Fletcher, of the Virginia station, is secretary-treasurer of the association. Each principal, agricultural teacher, or director in the 10 State agricultural high schools is an ex-officio vice president of the association, and these with the elective officers constitute the executive committee.

WISCONSIN.

The La Crosse County School of Agriculture and Domestic Economy at Onalaska, Wis., opened to students October 11, 1909, with an enrollment of 71 boys and 61 girls. A new two-story brick building, with a high basement and connected greenhouse, has been erected on the 17-acre farm which this school will utilize for instruction and demonstration purposes. The two-year course is similar to that in the other county agricultural high schools, except that it includes

military drill for men. A. A. Johnson is principal of the school, Miss Lucile W. Reynolds teacher of domestic economy, and P. L. Johnsrud teacher of agricultural engineering and manual training. A short course for farmers was held in the winter.

HIGH SCHOOL EXTENSION WORK IN AGRICULTURE.

The agricultural schools of secondary grade and the public high schools having departments of agriculture in charge of trained teachers of agriculture are finding many opportunities to serve their people in other ways than through the students in regular attendance at the schools. This work is usually done in cooperation with the State colleges of agriculture, the State agricultural experiment stations, or the United States Department of Agriculture, which have been liberal in supplying lecturers and illustrative material for short winter courses, farmers' institutes, corn congresses, local demonstrations, and various judging contests and other popular types of instruction in agriculture.

THE BALTIMORE COUNTY PLAN.

The Agricultural School of Baltimore County, Md., has in the single year of its existence developed some outside work for each class of people in the community. Before the opening of the school and before the building was completed, the principal elect and teacher of agriculture, a stranger to the State, was in the county getting acquainted with the people, making card indexes of them, and attending their agricultural meetings and teachers' institutes. In this way he acquired a fund of information concerning the people and their needs which has since served as a guide in the work of the school. Cooperation between the people and the school was the keynote of his creed and the first public meeting for the dedication of the new school building was a partial consummation of his plans. The success of this meeting, for which the men's agricultural club and the women's home interest club were made responsible, was the means by which the active interest of all the people was aroused and their attitude at this first meeting indicated that they could be depended upon to do their share toward making the school a success.

The first extension work undertaken was a series of monthly meetings for rural teachers who were being urged by the county superintendent to teach agriculture, but did not feel competent to undertake the work. They were invited to the agricultural school for an all-day session one Saturday each month. Several meetings of this sort were held, the morning hours being spent in lessons on general school methods and administration, while the afternoon was devoted to lessons in agriculture, illustrated by a laboratory exercise which each teacher was required to perform. Such exercises were chosen as could

be performed in the country schools with apparatus which the teachers themselves could make or assemble. At about the same time the principal began contributing lessons in elementary agriculture to a local educational publication which was sent free by the school authorities to every teacher in the county. In these ways some help was extended to the teachers, but it needs to be stated here that the meetings at the school were not sufficiently successful to warrant their being continued throughout the year, owing mainly to the poor transportation facilities, which made it almost impossible for teachers residing at a distance from the school to attend the meetings in stormy weather, or when the roads were bad.

For the adult farmers a course of 10 evening lectures was given, one lecture each week. The general subjects of these lectures were soils and fertilizers, and each lecture was illustrated by laboratory demonstrations and experiments. Outlines for each lecture were furnished to those in attendance who were requested to keep them and bring them to the next meeting. The lectures were understood to be serious affairs requiring close attention and some outside study and reading. They were intended for men, but quite a number of women asked and secured permission to attend. The first lecture was attended by about 60 persons, the second by 90, and so on, with an average of 125 persons for each lecture during the entire course.

At the close of this series of lectures a corn congress was held with morning, afternoon, and evening sessions for two days. Speakers were secured from the United States Department of Agriculture and from the Maryland Agricultural College and Experiment Station. All of the addresses were to be directly on corn growing and cooking, for the women, too, were to have addresses and demonstrations. It proved to be a very popular affair. Over 180 exhibitors sent in 10-ear exhibits of corn, and nearly 1,000 persons attended the sessions. Twenty rural schools held preliminary corn shows and sent their best exhibits to the corn congress. There were simultaneous meetings in different parts of the same building for men, women, and children. Meals were served at a lunch counter by the ladies of the women's club and the proceeds were given to the school. At the close of the last session the prize exhibits of corn were sold at auction to the highest bidder and in this way good seed corn was distributed throughout the neighborhood.

For the farmers' wives a series of monthly meetings was held on Saturday afternoons. Invitations were sent out to about 300 women living within driving distance of the school. The three school wagons were run over the regular routes to bring those who cared to attend the meetings. The sessions opened with a short general lecture by some prominent speaker and then, after a selection of music, the women divided into four groups, which remained the same through-

out the year. One group took a short course of instruction in domestic science, each member of the class working with the individual equipment placed at her disposal, which was the same equipment used by the students in the high school. Another group took carpentry work in the manual training room and was taught to use the plane, hammer, and other ordinary carpenters' tools in making shelves, towel rollers, and other common articles about the house and yard. The third group, known as the class in home crafts, was taught chair caning, rug weaving, Indian basketry, stenciling, etc., and the fourth took up a study of modern literature under the direction of the principal of the school. The meetings had an average attendance of 85 throughout the year and were successful.

A literary society was organized for the young people in the neighborhood who were not in school. The society met once in two weeks, had a membership of about 100 persons, and engaged in spelling bees, debates, and other literary exercises which enlivened the long winter evenings.

During the summer the high-school boys were required to conduct experiments at their homes under the direction of the principal, who kept in close touch with the work by visiting the students several times during the summer vacation. The experiments were scattered over a territory 25 miles long by 5 miles broad, and thus attracted much attention among the neighbors, and were of value as a demonstration of new methods of farm practice. The experiments were largely selected by the students under the suggestion of the principal and consisted of variety tests of corn from seed furnished by the school, tests of herds of dairy cows, including the keeping of milk records and the making of frequent Babcock tests of the butter-fat content, alfalfa growing, variety tests of cowpeas, variety tests of popcorn, and other similar experiments of simple nature which were attractive to the students and served to arouse interest in agricultural problems.

The school also tested seeds and milk for farmers. During the spring months many samples of clover seed were submitted for a determination of purity and vitality, and throughout the year milk and cream were tested. Many of the farmers of the neighborhood are engaged in dairying and sell their milk by the butter-fat test. These were glad to have an occasional authoritative test from a disinterested source to compare with tests made by the buyer.

The principal writes that the extension work of the school did not prove unusually difficult, nor did it disclose obstacles which would make it prohibitive for any school. On the other hand, it made many things easier for a new school just getting established in a rural community in that it secured the good will and hearty support of all its rural patrons.

THE STOCKTON PLAN.

One of the most comprehensive schemes for a high-school department of agriculture, including extension work, is that devised by Superintendent James A. Barr, of the Stockton (Cal.) schools. Stockton is a city of about 25,000 population, with 16 teachers and 450 pupils in its high school. The school is "rural" only in the sense that it is in the center of a rich agricultural region, from which it draws many of its pupils and for which it furnishes nearly all the teachers.

The Stockton plan, which was definitely adopted by the school board in 1910 and goes into operation in the fall, includes (1) two-year and four-year courses in agriculture and home economics closely related to the practical affairs of the farm and home; (2) work directly related to the agricultural problems of San Joaquin County, such, for example, as problems relating to peat lands, irrigation, alfalfa, grape growing, dairying, and local insect pests; (3) courses appropriate for girls along the line of household arts, dealing with the domestic, household, and health questions of the home, and including instruction in cooking, the chemistry of foods, invalid cookery, sewing, home nursing, house furnishing, sanitation, care of children, and home management; (4) short courses for farmers and those interested in agriculture who can not take a full course, to be given in a cooperative way by the school and the State college of agriculture; (5) the preparation of teachers to the end that both the graded and rural schools throughout the district may be provided with teachers having a knowledge of and a sympathy for farm life; (6) the publication and distribution of leaflets bearing on the agricultural problems of the district; and (7) the cooperation of the State college of agriculture, the United States Department of Agriculture, and the agricultural department of the high school in holding county and district institutes of teachers, farmers, and students jointly to consider educational and agricultural problems.

The high-school department of agriculture is to be in charge of an expert director, who will be called upon to teach not to exceed one-third of his time, the rest of the time to be devoted to a study of the agricultural problems at first hand throughout the farm area tributary to Stockton. The director in charge will be the connecting link between the problem of the individual farmer on the one hand and the research work of the United States Department of Agriculture and of the college of agriculture at Berkeley on the other. The director will take up any agricultural problem with any of the farmers at any time, go to their farms, and help in finding a solution. By this means the farmers will be reached directly and made to feel that the agricultural high-school course is their course and

that the director and teachers are willing and able both to educate their boys and girls for profitable farm life and to cope with the economic problems troublesome or burdensome to them. By this field work not only will the farmers be helped with their farm problems but the high-school work will be brought in touch with the real agricultural problems of San Joaquin County.

It is expected that the director will have charge of the work in nature study, elementary agriculture, and school gardening in the elementary schools of Stockton and will probably prepare a course of study in agriculture for the rural schools of the district tributary to Stockton.

A portion of the 10-acre high-school site will be utilized for experimental purposes, and it is expected that these experiments will be supplemented by others in various parts of the county to be conducted according to suggestions offered by the State experiment station, the United States Department of Agriculture, and the director of the agricultural work in the school. In this work it is planned to foster the introduction of new crops, to devise methods of increasing yields, eradicate insect pests, encourage better farm practice, study methods of packing and shipping grapes, and engage in other similar lines of agricultural work.

Arrangements will also be made with farmers in different parts of the county to permit the high-school students to make field studies on different types of soils with various agricultural and horticultural crops.

If such a plan is carried out a type of school work will be developed which will be of immense value to the agricultural interests of San Joaquin Valley and will be influential in rapidly extending and developing the usefulness of high schools throughout the country to their agricultural constituency.

AGRICULTURE IN NORMAL SCHOOLS.

The latest available figures in 1910 indicated that among the 214 colleges and schools at that time conducting teacher-training courses in agriculture, there were 156 State and county normal schools and 28 negro schools. The latter are usually combined normal and industrial schools. The State normal schools are employing competent teachers of agriculture as rapidly as they can be found, and these teachers are doing much to bring about a better understanding of rural life problems by the teachers sent out from the normal schools.

Short winter courses for farmers were among the features of popular work undertaken by the normal schools. Such courses were given in several of the Illinois schools. At De Kalb a short course was held during the week of December 6. Courses were offered in elementary agriculture, judging corn, horses, and dairy cows, testing milk, rope

splicing, spelling farm words, and domestic science, and special lectures were given by Dean Davenport of the college of agriculture, President John W. Cook and C. W. Whitten, of the normal school, Frank H. Hall, of Aurora, Ill., and others. There were 75 students in attendance, ranging in age from 11 to 68 years. The State normal school at Cape Girardeau, Mo., conducted a 6-weeks' course in agriculture for the benefit of those in the agricultural district surrounding this school who could not attend regular school work, but desired some training in the business of farming.

In accordance with an act passed by the last legislature requiring the teaching of agriculture in the three State normal schools in Texas and making appropriations for this purpose, the Sam Houston Normal Institute, at Huntsville, has employed a special teacher of agriculture and erected a new building which will provide an agricultural laboratory and other facilities for teaching agriculture.

For two years the agricultural department of the University of Tennessee has offered free scholarships in the Sumner School of the South, held at Knoxville, to several teachers in each county of the State who take the courses in elementary agriculture and horticulture, introduce this work in their own schools, and assist in getting it into the other schools of their county. These scholarships are worth \$10 each, and appointments to them are made by the various county superintendents. They admit appointees not only to the courses in agriculture and horticulture (four hours per day) but also to any of 200 or more other classes for which the teachers have time.

This year (summer, 1910) for the first time a course for teachers on the principles of agriculture is to be included in the instruction offered by the Biological Laboratory of the Brooklyn Institute of Arts and Sciences, at Cold Spring Harbor, Long Island, during the session beginning July 6. The course will be under the direction of Prof. H. H. Laughlin, of the Missouri State Normal School, at Kirksville, and will continue six weeks.

In Massachusetts cooperative efforts to promote better teaching in rural districts are being made by the agricultural college and the North Adams State Normal School, where three training schools are maintained, a city school with all the grades, a mill-village school with two rooms and eight grades, and a rural school with two rooms and six grades. Particular emphasis is laid upon the methods of conducting school and home gardens in connection with these training schools.

The Maryland State Board of Education, in accordance with an act of the general assembly in 1908, has selected a farm of 178 acres near Bowie, on the Pennsylvania Railroad between Washington and Baltimore, as a site for a new State normal school for negroes. Instruction is to be given in mechanic arts, trades, agriculture, and

domestic science, as well as the common school branches. George H. C. Williams, principal of the Montgomery County Agricultural School at Sandy Spring, has been appointed principal of the new normal school.

Dr. B. M. Davis, professor of agriculture in Miami University, Oxford, Ohio, is contributing a valuable series of articles on elementary and secondary agricultural education in America to the *Elementary School Teacher*. In these articles the author deals not only with elementary and secondary schools teaching agriculture, but also with other agencies engaged in promoting elementary and secondary agricultural education. Among the agencies that have already been considered are the United States Department of Agriculture, the United States Bureau of Education, State departments of education, State legislation, agricultural colleges, and State normal schools. It is understood that after the series of articles has been completed the various papers will be assembled and published in book form.

AGRICULTURE IN THE STATE NORMAL SCHOOL AT ATHENS, GA.

The State of Georgia requires agriculture to be taught in its common schools, and since the State normal school is concerned in the preparation of teachers for these schools it has for 11 years offered courses in agriculture. While these courses are of necessity somewhat limited and are as yet in a stage of development, they have become of sufficient importance to require the employment of a director of agriculture and one assistant. D. B. Jewell, director of agriculture, has furnished the statements and figures necessary for this description of the work. He writes that the interest thus far shown in the agricultural work and the results obtained offer great encouragement for the continuance and extension of the instruction in agriculture. That this interest is not merely ephemeral is shown by the fact that fully one-third of the 60 seniors in school who were not required to take the subject remained in the class.

Several graduates of the school are doing successful work in agriculture in the rural schools. One graduate is in charge of the boys' corn-club work of the State, and seven others are teachers in the district agricultural schools of Georgia. The demand in Georgia for teachers of agriculture is greater than the school can supply, and the department of agriculture is hoping to send out each year some good teachers especially prepared for this work.

Every student who completes one of the prescribed courses in the school is required to take some work in agriculture. For example, the class known as "Review C," which is a half-year class beginning work in September and January, has two periods a week from an



FIG. 1.—JUNIOR NORMAL PUPILS RECORDING PLAT NOTES.



FIG. 2.—SECTION OF SENIOR CLASS JUDGING CORN, GEORGIA STATE NORMAL SCHOOL.

elementary textbook supplemented by outside reading and observation. "Review B" class, which has a year's work in the common school subjects, has also textbook work in agriculture with a larger amount of outside reading and observation work than the other class. The work of this class in studying seeds is shown in Plate XVIII, figure 2.

In the regular three-year course of the school the first-year students have a year's work in botany (ecology). The next year when they are in the middle class their science work consists of experimental garden work with fertilizers and varieties of vegetables and other plants, together with classroom experiments and exercises. The work of one section of this class is shown in Plate XIX, figure 1, where the students are taking notes on the progress of their experiments. The plats in this garden are arranged in groups of 6, each plate being 5 by 10 feet. In the first group salad turnips and onions were planted; in the second, wheat; in the third, oats; in the fourth, one-half to vetch and oats, and one-half to crimson clover and oats. One extra plat was planted to Canadian peas and crimson clover, and another to lettuce and radishes. The sixth group was a fertilizer experiment with the same plants on all of the plats but a different fertilizer on each as follows: Plat 1, no fertilizer; plat 2, cottonseed meal and muriate of potash; plat 3, cottonseed meal and acid phosphate; plat 4, muriate of potash and acid phosphate; plat 5, a complete fertilizer; and plat 6, barnyard manure. This work is started at the opening of the school in the fall and extends into the winter. The school has about an acre of ground, which has been inclosed for the use of students in this experimental garden work.

The classroom exercises in elementary agriculture are largely taken from Farmers' Bulletin 408, *School Exercises in Plant Production*. The students collect the necessary material and perform the laboratory experiments. Where experiments with plants are called for the planting of the seed is done in the laboratory, and the pots are then taken to the students' rooms to allow the plants to develop. When results are obtained the plants are brought to the instructor, the work described, and the student given credit.

In the gardening course the students work by groups and are required to keep full notes and records of work done in their own group and in other groups. They are also given instruction in planning gardens, computing cost of production, mixing fertilizers, budding, grafting, spraying, and in all the common phases of farm work which they are likely to come in contact with in the rural districts.

The work of the "Diploma C" or senior class is divided into two parts. The first part consists of a study of the rural-life problem as it affects the Nation generally and the State of Georgia particularly. The subject is approached by an investigation of present conditions,

their causes, and remedies. A close watch is kept for current articles on the subject. A study is made of the report of the Country Life Commission. Means of arousing local interest, the formation of school organizations, and the application of what has been taught to the average one-room country school are given especial consideration.

The second part of the senior work consists of a detailed study of a few important crops, such as cotton, corn (Pl. XIX, fig. 2), and the other cereals. In the work on corn Farmers' Bulletins are used, particularly Farmers' Bulletin 409, School Lessons on Corn. Instruction is also given regarding live stock and truck farming. All subject matter is taught and all experiments are performed with the idea of adapting the work to rural school conditions where interest is apt to be lagging and apparatus lacking.

In the practice school the seniors are required to oversee the work of the children and become familiar with the methods of conducting it. The school has, in addition to the land used for instructional purposes, a small dairy and truck farm of about 20 acres. This supplies products for the college dining hall and affords the students opportunities for observation and study. This small farm produced in 1910 more than \$4,000 worth of milk, vegetables, and other farm products.

The idea pervading the whole course is to arouse an interest in agriculture, an appreciation of the needs of the country, a perception of the possibilities in the country, an inclination to be of real service to the country, and a desire to live in the country.

THE ELEMENTARY SCHOOLS.

The work of the normal schools in preparing teachers of agriculture and the extension of this privilege to some of the agricultural schools are having a good effect upon the movement for the introduction of agriculture into the elementary schools. But as in former years the most effective work in elementary agriculture has been accomplished where the school work in this subject has been combined with some form of competitive endeavor—boys' corn clubs (Pl. XX, fig. 1), girls' domestic science clubs, and the like.

The colleges of agriculture continue to take a helpful part—often a leading, directing part—in promoting rural education, by preparing and giving wide circulation to extension circulars and conducting various forms of contests. In the South several of the agricultural colleges have cooperated with this department in employing school-extension agents. The number of boys engaged in corn-growing contests under the joint auspices of these colleges and this department was this year (1910) more than 46,000.

In the college of agriculture of the University of California a section of elementary agriculture has been organized in connection with



FIG. 1.—SHEEP JUDGING AT FARM BOYS' ENCAMPMENT, CLARINDA, IOWA.



FIG. 2.—CHILDREN STARTING HOME FROM MODEL RURAL SCHOOL, KIRKSVILLE, MO.

the department of agricultural education, and from it several helpful and very suggestive publications have come.

In Massachusetts a committee of five appointed by the conference on agricultural science at the Massachusetts Agricultural College in 1908 has prepared and the agricultural college has published a course in elementary agriculture which consists of a series of practical exercises, for each of which appropriate materials and directions are suggested. There are 54 of these exercises, covering such topics as types of soil and subsoil, plant roots and root nodules, effect of humus and lime in clay soil, determination of the percentage of water and air in soils, testing soil solutions for acidity or alkalinity, soil temperatures, capillarity and evaporation, soil drainage, transpiration in plants, study of various seeds, corn germination, variations in plant growth, improvement by selection, home gardening, grafting, pruning, and budding, plant enemies and diseases, preparation of Bordeaux mixture, milk testing, and milk bacteria.

The summer encampment scheme described in my last report has assumed several new forms. In Oklahoma and Illinois it is announced that in the fall of 1910 agricultural encampment schools for boys will be held at the State fairs. In Iowa, P. J. Horchem, of Dubuque, has held one successful vacation farm school for city boys and is planning to extend his efforts along this line to other places. In Kansas the "call of the wild" is answered by the organization of Rural Life Boy Scouts.

Accompanying all the sentiment and agitation for the improvement of instruction in the rural schools there is a growing belief that the physical condition of these schools should be improved in many ways. Indeed, many educators believe that some measure of physical improvement must precede effective reorganization of the instruction. And so, several of the State departments of education and some of the colleges and normal schools are studying the problems of physical improvement for these schools. The department of public instruction in Illinois has published a pamphlet entitled "The One-Room Country Schools in Illinois," which contains many excellent suggestions for improving the buildings and equipment of these schools—the lighting, seating, heating, and ventilation.

A MODEL RURAL SCHOOL.

The State normal school at Kirksville, Mo., has given much attention to rural education, and of late has been developing a model rural school building (Pl. XX, fig. 2). This is described as follows in a recent bulletin of the school:

The model rural school exemplifies the simplest and yet the most complete, practical, and economical architecture ever devised anywhere for rural or village schools, and the most effective facilities for instruction used in schools of corresponding grade anywhere. The children are transported from their

farm homes several miles away in a covered wagon. This model rural school solves many of the problems of country life. That is what it is for.

In solving the one-room school problem and the one-teacher school problem, we have solved the problem of the consolidated rural school and village school, since the equipments described in this circular are easily adaptable to buildings of several rooms.

This model rural school has three principal floors: The basement, the first floor, and the attic.

DESCRIPTION OF BASEMENT PLAN.

The basement is rectangular (fig. 3). It is 28 by 36 feet outside measurement—8 feet from floor to ceiling. The floor is of concrete, underlaid with porous tile and cinders. The tile leads into a sewer.

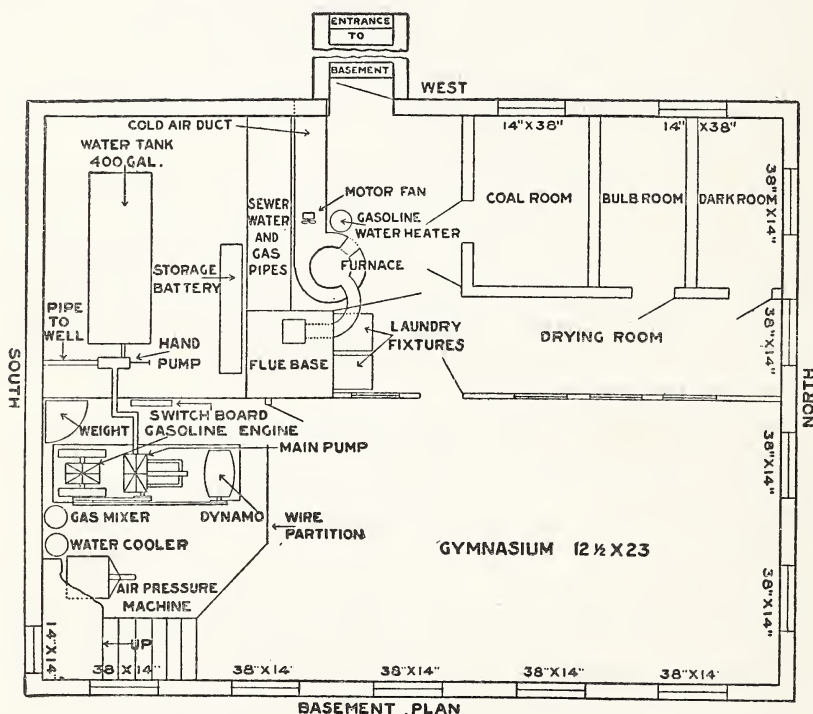


FIG. 3.—Basement plan of model rural school.

The walls are of concrete, protected from undue moisture by an outside tile, a foot from the walls and averaging 3 to 7 feet beneath the surface of the ground, sloping rapidly into the main sewer. The ditch above the tile is filled with cinders.

The outside entrance to the basement is of concrete, with an outside drain through the lower step into the sewer. The steps of the outside entrance to the basement and all other steps are of uniform height and tread, about 7-inch riser and 11-inch tread.

The basement has eight compartments: 1, Furnace room, containing furnace inclosed by galvanized iron; also double cold-air duct with electric fan; also gas water heater; 2, coal bin, 6 by 8 feet; 3, bulb or plant room, 3 by 8 feet, for fall, winter, and spring storage; 4, dark room, 4 by 8 feet, for children's

experiments in photography; 5, laundry room, 5 by 21 feet, with tubs, drain, and drying apparatus; 6, gymnasium, 13 by 23 feet; 7, tank room, containing a 400-gallon pneumatic pressure tank, storage battery for electricity, hand pump for emergencies, water gauge, sewer pipes, floor drain, etc.; 8, engine room, containing gasoline engine, water pump, electrical generator, switchboard, water tank for cooling gasoline engine, weight for gas pressure, gas mixer, batteries, pipes, wires, etc.

The pumps lift water from a well into pressure tank through pipes below frost line. Gasoline is admitted through pipes beneath frost line from two 40-gallon tanks underground, 30 feet from building. Rooms are wired for electricity and plumbed for gas.

The basement in all parts is thoroughly ventilated.

DESCRIPTION OF FIRST-FLOOR PLAN.

Figure 4 shows pretty clearly the schoolroom, toilet rooms, hallways, and stairway connections.

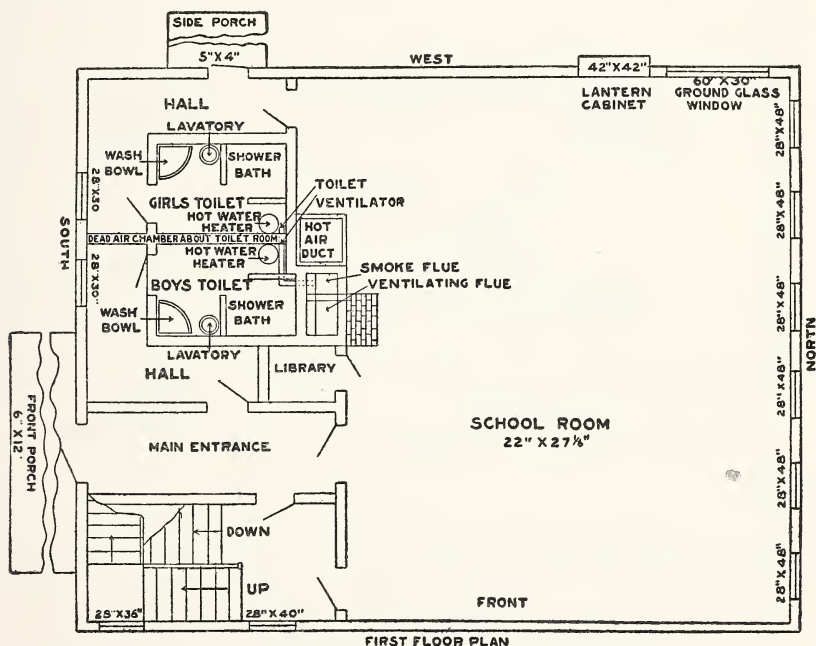


FIG. 4.—First-floor plan of model rural school.

The schoolroom is 22 by 27 feet in the clear. The children face the east. Mild light in abundance enters the room from the north, which is on the left side of the children; ground-glass window at rear admits sunlight for sanitation.

The schoolroom has adjustable seats and desks, telephone, and teacher's desk. A stereopticon is hung in wall at rear; screen at the front. An alcove or closet is on the east side for books, teacher's wraps, etc.

The school has a small organ, ample bookcases, shelves, and apparatus. Pure air enters above children's heads and passes out at floor into ventilating stack through fireplace.

In figure 4 observe the toilet rooms. Each one has all ordinary toilet fixtures—lavatories, washbowl with hot and cold water, pressure tank for hot water and for heat, shower bath with hot and cold water, ventilating apparatus,

looking-glass, towel rack, soap box, and other accessories. Each toilet room is reached by a circuitous passageway, furnishing room for children's wraps and overshoes. Scheme for perfect privacy in toilet rooms. All toilet-room walls contain air chambers to deaden sound. The toilet rooms are clean, decent, and beautiful.

The main entrance to schoolroom is through a porch. There is a small porch on west side especially for girls. All rooms are wired for electricity and plumbed for gas. The walls are adorned with pictures.

DESCRIPTION OF ATTIC PLAN.

Every rural schoolhouse has an attic, but this seems to be the only one whose attic was ever discovered. This attic is 35 by 15 feet, inside measurement, all in one room, as shown by floor plans in figure 5; distance from floor to ceiling, $7\frac{1}{2}$ feet in middle part.

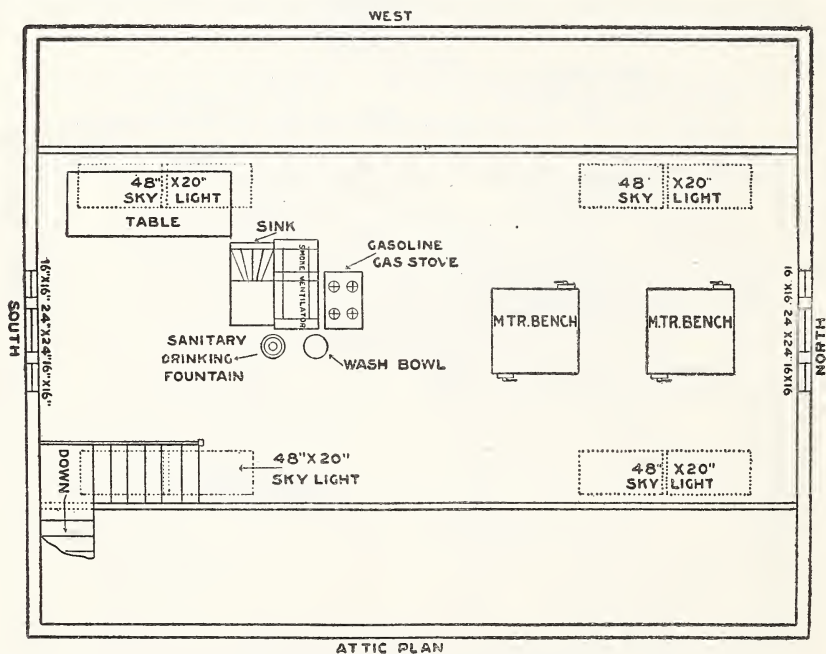


FIG. 5.—Attic plan of model rural school.

The attic is abundantly lighted through gable lights and roof lights. It contains modern manual-training benches for use of 8 or 10 children at one time. It has a gas range and other apparatus for experimental cooking. It is furnished with both gas light and electric light.

It has a washbowl with hot and cold water, looking-glass, towels, etc. It has a large sink, such as a good kitchen usually contains. It has a drinking fountain, but no drinking cup, either common or uncommon. It has cupboards, boxes, and receptacles for various experiments in home economics.

It has a disinfecting apparatus and a portable chemistry-agriculture laboratory, and numerous other equipments. Its utilities will grow in number and improve in quality. It is properly heated and ventilated.

It has a disappearing bed, which slides out under the lower roof, except when in use. The bed is used by the young man who acts as janitor.

This attic is from all points of view sanitary.

THE FARMERS' INSTITUTES IN THE UNITED STATES, 1910.

BY JOHN HAMILTON,

Farmers' Institute Specialist, Office of Experiment Stations.

Progress in farmers' institute work during the year has been general. The number of institute sessions has been greatly increased, a much larger attendance is reported, and more liberal appropriations were made than in any preceding year. Institutes were held in all of the States and Territories excepting New Mexico, Nevada, Alaska, and Hawaii. The districts, however, in which no institutes were held do not contain a very large population, the total given by the census of 1910 being 665,441; of this number about one-half (327,301) are in New Mexico.

INSTITUTES HELD.

The total number of regular institutes held was 5,651. These were made up of 3,539 one-day meetings, 1,940 two-day, and 172 three or more days, an increase over the previous year of 494 one-day institutes, 118 two-day, and 26 of three days. The whole number of days of institutes in 1910 was 7,935, an increase of 801 over 1909.

SESSIONS.

The number of sessions was 16,586, or 1,051 more than in 1909. Since the session is the proper unit for estimating institute progress, the large increase in 1910 over the previous year is unmistakable evidence of the rapid development of the work.

ATTENDANCE.

The attendance reported at all of the regular institutes was 2,395,908, as against 2,240,925 in 1909, an increase of 154,983. The average attendance per session was 144, or 2 less than the average for the previous year.

APPROPRIATIONS.

The appropriations from all sources in 1910 were \$432,374.25, or \$86,707.76 more than in 1909. The appropriations from the State legislatures directly for institute purposes was \$372,430.48 and the amount received from other sources was \$59,943.77. The amount

expended for institute purposes did not equal the appropriations made by \$17,027.96. Failure to expend the full amount appropriated was, however, confined for the most part to six States.

AGRICULTURAL COLLEGE AND EXPERIMENT STATION AID.

The agricultural colleges and experiment stations have continued to aid the institutes by detailing members of their faculties and station staffs for lecture service. Four hundred and eighty of these lecturers, representing the agricultural colleges and experiment stations in 43 States, were engaged in institute work last year. Thirty-nine of the States and Territories reported the days of service contributed by their lecturers at 4,780. The previous year the same number of States reported 459 college and station men engaged in this work, and of these 34 reported the days contributed at 3,381. There is, therefore, an increase of 21 men in 1910 over the previous year and of 1,399 days of service. It will thus be seen that there has been a considerably larger contribution of both men and time to institute work in the past year by the colleges and stations than during the year before.

SPECIAL INSTITUTES.

In addition to carrying on the work of the regular institutes the States have been maintaining a number of special meetings of institute character. Some of these special forms of institute activity have become so well established and attended as to be entitled to recognition as distinct features, to be reported separately. Accordingly, a new form of report blank has been prepared for the coming year in which space has been provided for data giving information respecting these distinct lines of work.

Among the various forms of institute activity that have developed none are more promising than the movable schools of agriculture. Schools of this character were reported by eight States. Four hundred and twenty-three sessions were held, attended by 65,977 persons. Two special-subject institutes were reported by one State, with an attendance of 1,600. Five hundred and seventeen independent institutes were reported by 16 States, with an attendance of 157,523, and twenty round-up meetings were conducted by 17 States, composed of 144 sessions, and attended by 43,056 persons. Fifty-six picnics and harvest-home meetings were reported, with an attendance of 30,241. One State held a meeting in connection with its normal school, attended by 147 teachers. Sixty-nine field demonstrations were conducted, with an attendance of 22,875. Twenty-nine railroad instruction trains were run by 19 States, with an attendance of 189,645. Four hundred and forty-four institutes for women were held in 15 States. The attendance is reported by only one State, which gives

the number at 4,850. One hundred and sixty sessions of institutes for young people were held, with an attendance of 21,422. The directors of two States reported that 50,000 school children were visited and addressed by their institute directors during the year and a number of others report similar service, but do not give the schools visited or the number of children in attendance. It is, however, safe from the data furnished, to assume that at least 100,000 school children were visited by institute men during the year, and given some instruction in either agriculture or domestic science.

The aggregate attendance at all of the special institutes as reported was 537,336, making the total attendance at institutes of all kinds for the year 2,933,244, an increase of 74,365 over the year before.

AGRICULTURAL COLLEGE EXTENSION WORK.

The development of agricultural extension by the land-grant colleges has been one of the most remarkable features of their work during the year. The report of the standing committee on extension work of the Association of Agricultural Colleges and Experiment Stations shows that extension departments have been organized in 32 States and Territories by 35 institutions, and that in 3 other States departments have been partially organized. One hundred and thirteen persons were employed for their full time in extension work in connection with the colleges and stations and 189 persons contributed part of their time. Appropriations from all sources for carrying on the work during the year amounted to something over four hundred thousand dollars. The standing committee renewed its recommendations of the previous year for national appropriation for extension work. This recommendation was afterwards indorsed by the association.

The new section of the association on extension work held its first session at the Washington meeting. The program provided for the discussion of agricultural extension as to its present status, extension schools, training extension teachers, and agricultural extension as related to rural schools. The section on experiment station work also devoted the greater part of an afternoon to the consideration of the relation of the experiment stations to extension work, and the college section met with the extension men in a joint session for the discussion of extension methods. Interest on the part of the association in this new feature in education was very pronounced.

In recognition of the importance of extension work as a feature in agricultural education, the committee of the Graduate School of Agriculture a year ago provided in its curriculum for the meeting at Ames, Iowa, a period for the presentation of papers relating to rural sociology and agricultural extension. The interest excited among the students by these papers was quite remarkable, and

resulted in a request that they be published for the information of teachers and others responsible for education by extension methods. The department accordingly has issued these papers as a bulletin of the Office of Experiment Stations.

THE AMERICAN ASSOCIATION OF FARMERS' INSTITUTE WORKERS.

The annual meeting of the Farmers' Institute Workers of the United States and Canada was held in Washington, D. C., last November. At this meeting there were representatives from 37 States, the District of Columbia, and 3 of the Provinces of Canada. The discussions were classified along the lines of institutes for women separate from those for men, but affiliated with the present institute system as auxiliaries, and institutes for young people between the ages of 14 and 18.

The discussions relative to women's institutes were confined principally to papers presented by representative women who had experience in institute work in various parts of the country. It was shown that institutes for women were being conducted successfully by a number of the States. The Province of Ontario was, however, the most striking example quoted of the organization of women upon a considerable scale. There are now in this Province over 600 separate institute societies for women with an enrolled membership of over 16,000 persons. Five thousand four hundred and eighty-three sessions of women's institutes were held last year in that Province with an attendance of 140,388.

A resolution was adopted by the association recommending that greater consideration be given by institute directors to subjects relating to home life, either through the organization of special meetings for women or in the regular institutes.

An entire session was set aside by the association for the discussion of institutes for young people between the ages of 14 and 18. It was shown that out of every 500 young people in the country districts of the United States only one ever enters an agricultural college, and that out of every 100 rural and urban children only 5 enter the high school, and only 6 ever get beyond the elementary schools. In order to provide for young people between the ages of 14 and 18, out of school, institutes similar to those for adults were advised, in which vocational training would be predominant. A resolution embodying the sense of the association in this matter was adopted recommending the several directors of farmers' institutes to make the experiment within the next year of holding some institutes for young people between the ages of 14 and 18, and to report their success or

failure to the institute specialist. This new field of effort was recognized as belonging specially to the farmers' institute organization and as being one that is in great need of immediate attention.

The association also gave consideration to the condition of the negro farmers of the South and directed that at the next annual meeting a report be made regarding their progress in farmers' institute work and their general agricultural advancement.

The employment of experts by the year to visit farmers and give personal instruction respecting the best methods in the management of their crops, also to conduct demonstrations, organize farm clubs, and perform such other similar itinerant service as may be necessary was recommended to the directors to be put into immediate operation. The association also submitted to the dean of the Graduate School of Agriculture the question of providing in future courses in that school for instruction in institute and other forms of extension work.

INSTITUTES FOR YOUNG PEOPLE.

Now that institutes for adults have demonstrated their value and have become well established in all of the States, attention is being directed to the needs of a class of people in the country districts between the ages of 14 and 18 who have left school and are without opportunities for properly fitting themselves for taking charge of farming operations. The public schools in some States are teaching nature topics in their bearing upon country life, but this is to children between 10 and 14 years of age, and by rural school teachers not prepared to instruct in the vocational side of farming except in a quite limited way. Young persons, therefore, in the country reach the age of 14 without very much training in farming and household economy except through the purely practical operations which they perform in the ordinary routine of farm life.

The institute is proposing to organize these youths after they have left school into associations or institutes under the direction of the institute officials and provide instruction of vocational character of a grade adapted to their age and experience with such other educational exercises as are important to their development. These institutes differ from boys' and girls' clubs as organized by the public schools, in that they are officered by adults and the instruction is by experts in agriculture and household economy and art.

In aid of this movement, the Office of Experiment Stations has published a circular entitled "Farmers' Institutes for Young People," in which suggestions are offered for organizing and conducting this kind of extension work.

INSTITUTES FOR WOMEN.

In making the country home a special department in institute organization and effort, through the organizing in rural districts of societies composed altogether of women, the paramount importance of woman's work as the home builder is recognized by the State, and systematic effort made to aid her from the public treasury, equal to that now given to workers in the field.

That this work is coming into appreciation is shown by the fact that 16 States held 444 institutes for women last year, or 299 more than were held during the previous year. Before, however, they will increase with the rapidity that their importance demands it will be necessary for the State directors to send out organizers to call meetings for women and organize them into clubs as auxiliaries to the farmers' institutes of the county and State. If this were done their number would increase many hundredfold within a year. As soon as the State directors come to see and appreciate the importance of this phase of their work such organizers will be employed and women's institutes established equal in number at least with those now in operation for men.

A method of organizing women's associations that seems to have worked well has been put in operation in Oklahoma. There the county farmers' institute is chartered by the State upon application of not less than 15 farmers resident in the county and is continued upon the payment of an annual membership fee of not less than 50 cents per member.

A county woman's auxiliary of the farmers' institute may also be organized in each county. These auxiliaries are empowered to organize separately from the farmers' institutes and work under separate programs. To be entitled, however, to recognition by the State they must charge and collect an annual membership fee of not less than 25 cents per member and must make report to the county institute showing their membership and giving the name of each member. No name can be listed unless the person shall have paid a membership fee of at least 25 cents for the year. The statement must show also the total amount of the membership fees collected in the county and give an itemized list of the expenses of the auxiliary for the year, accompanied by receipted vouchers showing payment in full of all expenses so itemized.

Upon compliance with these provisions the report of the auxiliary is made a part of the report of the farmers' institute of the county, and the auxiliary is entitled to its pro rata share of the county funds appropriated for the support of the institute work.

Branches of this county woman's auxiliary may be formed and become a part of the county association. The State organizer or

superintendent of the women's auxiliaries visits the associations in the various counties at the expense of the State institute department, organizes new county associations and local clubs, and keeps in correspondence with these auxiliaries during the year.

FAIR ASSOCIATIONS.

A recent investigation by the institute specialist into the condition of the county fair associations shows that there are over 1,200 of these societies in the United States with a registered membership of approximately 250,000. Their gross receipts for the year 1909 amounted to about \$6,500,000 and their expenditures for premiums to about \$2,500,000. These societies are incorporated under the laws of their respective States and so have continuous existence and in many cases have an assured income for their support. That they have not been utilized by agricultural educators in the past as they should is quite evident to those who have studied their capabilities.

A strong, local organization is needed in every county to form a center to which rural people in the country can look for information and assistance in carrying on their work. The agricultural colleges also, now that they are undertaking extension work in agriculture, need an organized body of men in each county to act as their agents in disseminating information and for attending to local matters that require the presence of some one on the ground familiar with local conditions. The State departments of agriculture, likewise, are interested in having a representative in each county as a correspondent to gather information and to report periodically the condition of the crops, the state of the markets, the presence of contagious diseases among animals, of injurious insect pests, or fungus diseases among plants. In these and many other directions a fair association can be useful to the community in which it is located and to the country at large. The agricultural colleges are already using these societies for making known their work and for disseminating information useful to farming people. Forty-eight colleges and stations exhibited at 101 county and State fairs in 1908, and every one reports that it was greatly to their advantage.

Most of these societies need redirecting—to be given a new and enlarged view of their position and responsibility. A start has been made in this by the institute office through correspondence and by collecting information respecting the workings of the fair associations throughout the country for the benefit of those who are engaged in the management of these societies.

The field of opportunity that this opens up in the way of disseminating agricultural information is very large. The energy and advantage that these societies possess have hitherto been largely

unutilized by institutions and agencies outside of the bounds of the counties in which the fairs are held. This should no longer continue, but systematic effort for their improvement and utilization should be begun.

AGRICULTURAL INSTRUCTION TRAINS.

The popularity of the instruction train is growing each succeeding year. Twenty-nine of these trains were reported as having been run during the year ended June 30, 1910, by 18 States, with an attendance of 189,645. These trains are equipped with material for illustrating the points that are presented by the lecturers and are run at the expense of the railroad companies. Numerous other trains of similar character were run during the year, but not being under the direct management of the institute authorities they were not included in their reports.

An investigation now being made into the extent of this new method of disseminating agricultural information shows that the transportation companies are awake to the possibility of increasing agricultural production by this means and are exerting themselves to bring about this increase as soon as practicable. Everywhere there is not only the most cordial cooperation of the companies with the colleges and other agricultural agencies in this propaganda, but they are urging forward the movement as rapidly as the means at their command will permit. A number of the great transportation lines have employed agricultural experts by the year to look after the development of agriculture throughout their territory and have established demonstration farms to show what can be done under skillful direction in increasing production in some of the more backward sections. The movement promises to be one of the most important in aid of agriculture that has yet been inaugurated.

REPORTS OF LOCAL MANAGERS.

The extent to which State directors of institutes seek advice from their local managers in the several counties and are guided by the information thus obtained is not definitely known. That there should be the most friendly and harmonious action between the State directors and the local managers in the management of the institutes is clear if the work is to be thoroughly developed and be most effective. In order to do this there must be on the part of both complete knowledge of local conditions. In a few States general and district conferences of the local managers are called each year at which the local situation in the various districts is discussed and the work for the future planned with a view to aiding the communities with information adapted to their needs.

In order to prepare for these conferences and to keep before the State directors the needs of the localities and the changes that are continually occurring, a system of reporting every month or quarter by the local manager should be inaugurated, giving information as to the effect of previous institutes in bringing about changes in farm practice, the number of new agricultural organizations formed, the names and addresses of leading farmers and others interested in agriculture, the value of farm lands as indicated by sales actually made, the system of cropping pursued, the condition of the public roads, the character of the rural schools, the directions along which information is most desired, suggestions for the improvement of the institute work, and the names of local people who could be depended upon for the intelligent discussion of various topics that the institute might present, together with other information that would enable the State director to know thoroughly the situation in every rural district in his State.

An investigation was recently made by the institute specialist through the local managers in the several States with a view to securing at first hand exact information respecting the farmers' institute work along several distinct lines. Inquiries were sent out to 3,309 local managers in 40 different States, and replies, more or less complete, were received from 998 of these managers representing all of the States addressed.

The following are the queries to which answers were solicited:

(1) What, in your opinion, is the best system of local organization for farmers' institutes?

(2) What more economical methods for conducting the institutes can be adopted?

(3) How can the supply of capable instructors be increased?

(4) What can be done to improve the methods of instruction?

(5) Are the farmers in your locality ready to organize separate institutes for women?

(6) Are the farmers in your locality ready to organize separate institutes for young people between the ages of 14 and 18?

(7) Are the farmers in your community ready for advanced instruction in agriculture by means of movable schools of agriculture?

(8) What is your opinion as to the wisdom of employing at least one traveling expert in your county to visit farmers and give advice respecting the improvement of their operations?

(9) Do the farmers generally take the bulletins from your experiment station and the National Department of Agriculture? If so, do they practice their teachings?

(10) What improvement of the institute work do you suggest for your community and your State?

In reply to query No. 1, as to the best system of local organization, 95 indicated the grange; 187 advised county and township institute organization; 109 were in favor of farmers' associations and clubs; and 132 were satisfied with the present form of organization.

With respect to query No. 2, as to more economical methods, 73 replied that the present system was satisfactory; 68 wished more money appropriated instead of less; and 106 were in favor of the employment of more local speakers.

To query No. 3, relative to increasing the supply of institute instructors, 77 replied, pay higher salaries; and 295 advised the use of more local speakers.

To query No. 4, as to improving the methods of instruction, 182 suggested the use of more illustrative material and demonstrations, and 97 suggested the employment of lecturers with more practical experience.

To query No. 5, as to whether the people of their communities were ready to establish institutes specially for women, 271 answered yes; 85 were undecided; and 549 that they were not.

To query No. 6, respecting institutes for young people, 213 answered yes; 111 were undecided; and 580 that they were not.

To query No. 7, 511 replied in favor of movable schools; 175 were undecided; and 233 were against.

To query No. 8, 698 were in favor of the itinerant adviser and instructor; 99 were undecided; and 149 against.

To query No. 9, 475 replied that the farmers generally take the bulletins from the State experiment station and the National Department of Agriculture; 168 were not able to express an opinion; and 297 answered no. As to practicing the teaching of these bulletins, 429 replied that they did; 498 were uninformed; and 117 answered no.

These replies, coming from all sections of the country, indicate pretty accurately the sentiment of farming people respecting the points submitted for their opinion. The movable school and the itinerant adviser are approved by a large majority, while the women's institute and an institute for young people are as yet too undeveloped to be judged by their actual work. Where they have been fairly tried they are approved.

In Illinois, out of 37 replies, 14 were in favor of women's institutes; 11 were undecided; and 13 were against them. In Indiana 15 were in favor of women's institutes; 2 were undecided; and 10 answered no. In Nebraska 43 were in favor of women's institutes; 1 was undecided; and 35 were against them.

The young people's institutes have not yet been developed in any State to test their character; consequently the replies were not based upon experience actually had, but were mere opinions unsupported by any facts as to their working that the reporter had observed.

Some kind of local organization was generally agreed by the correspondents to be a necessity for the proper working of the institute system. Teachers with practical experience were everywhere demanded, and a larger number of these were regarded as necessary for

maintaining the efficiency, as well as for economy of service. In the method of teaching, illustrations and demonstrations showing the truth of the theories advanced were generally recommended.

The reports as a whole show that the institute teacher who is to interest and benefit farmers in the time to come must be able to show the practical applications of science to agricultural operations.

ECONOMY IN INSTITUTE EXPENDITURE.

While the conditions in the various States are such as to prevent anything like uniformity in the cost of the institutes, yet there seems to be too wide a range between the cost in some States over that in others doing presumably as efficient work. An examination of the cost per session for the year ended June 30, 1910, shows a variation of 367 per cent between the lowest and highest, and from 6½ cents per individual present at these sessions to 62 cents per individual.

Sixteen States expended an average of \$40.43 for each institute session. These States represent a total expenditure of \$183,175.06, and held 4,529 sessions.

Twelve States expended on an average \$26.22 per session, representing a total expenditure of \$112,883.38, and 4,304 sessions held.

Eighteen States expended an average of \$15.38 per session, representing 7,753 sessions held and a total expenditure of \$119,287.85.

One State expended on an average \$4.30 per session; another \$8.45; and another \$8.59.

If the entire institute system of the country could be run upon the amount per session, \$15.38, expended by 18 States, there could be added without increased cost to the country 10,029 sessions of institutes to the present number of 16,586, or over 60 per cent.

These facts show that there is manifestly need for careful study on the part of many institute directors of the practice in other States with a view to the more economic use of their institute appropriations and the better utilization of their institute force.

IMPROVEMENT OF THE INSTITUTE SERVICE.

The weakest point in the farmers' institute at present is in its failure to see that its teaching on the platform is put into practice. Valuable information is given at an institute meeting. At its close the whole matter is dropped for a year, possibly never to be again referred to. There is failure to "follow up" by personal effort what has been recommended and to make sure that the teaching of the institute is not lost and that the money of the State expended at that meeting has not been wasted.

Giving instruction is only a part of the duty of the institute. Getting information into the practice of the people is the main purpose for which the farmers' institute is organized. After the information has been given the chief work of the institute begins. If the teaching has been the growing of fruit, then in all communities where this has been advised some one should be located to see that at least a few of those who were instructed take up the work and carry it on according to the method proposed. If, as at present, this is left to individual initiative, it may or it may not be done and often, even if undertaken, may fail for lack of proper and timely expert attention and advice. More time and more money should be spent after the lecture in getting it applied than in its preparation and delivery. The discovery of the principle of the telephone was a great matter, and yet getting it into general use was fully as important and a far more expensive affair. Until it was in use it was unfruitful. The same is true of every great discovery and truth. It is valueless until put into use.

Special attention, therefore, should be given in the future by institute directors to getting the facts that are presented before institute audiences incorporated into the practice of the community. For this, special agents of the institute department should be detailed to see that in some way, either by one or more farmers in the community or independently by the institute department, the thing that is proposed is actually undertaken.

If the "follow up" principle is adopted by institute directors, there will be a curtailment of the number of subjects taught and a greatly increased amount of practice in demonstration of the teaching. This will be in accord with the general desire as expressed by the local managers of farmers' institutes in their reports respecting the improvement of the institute service.

WORK OF THE OFFICE.

The work of the office of the institute specialist during the year has been in the direction of securing information respecting the condition and progress of farmers' institutes and agricultural education extension in this country and abroad and in preparing copy and editing for publication bulletins, circulars, and reports upon farmers' institutes and agricultural extension work. The office has cooperated with the American Association of Farmers' Institute Workers in the preparation of its programs, reporting its proceedings, and in preparing them for publication. It has also cooperated with the Association of American Agricultural Colleges and Experiment Stations in collecting and tabulating information for the use of the committee of the Association on Agricultural Extension and in conducting correspondence as secretary of that committee.

During the year a circular entitled "Farmers' Institutes for Young People" was prepared by the institute specialist and his assistant; the list of institute directors and lecturers was revised; a bulletin entitled "College Extension in Agriculture" was compiled and edited; an illustrated lecture upon wheat culture was published and another upon country homes has been prepared and is ready for the printer. A circular on Progress in Agricultural Education Extension was prepared and published and also the Annual Report on Farmers' Institutes in the United States. A course of lectures on the preparation of vegetable foods for use by movable schools of agriculture is in course of preparation, as is also a similar course in economic entomology. There are, likewise, a number of farmers' institute lectures illustrated by lantern slides being prepared similar to those already published. A very complete index, for use in the classification and registration of lantern-slide illustrations, was completed by the assistant institute specialist, who has also made card reference records of articles in foreign publications referring to farmers' institutes and agricultural extension work.

An investigation was conducted into the condition of county agricultural fair associations in the United States; another to secure expressions of opinion by the local managers of farmers' institutes concerning the condition of farmers' institutes in the various counties; and another into the status of college extension work in agriculture as conducted by the agricultural colleges and experiment stations in the several States. A further investigation has been made into the service rendered by railroad instruction trains during the year with a view to suggesting improvements in that service.

The institute specialist took part in the program of exercises of the Graduate School of Agriculture at Ames, Iowa, and he and his assistant have assisted in various other meetings held in the interest of agricultural extension throughout the country.

There has been in addition the usual correspondence with institute and extension workers and others making request for information, the filling of applications for illustrated lectures and agricultural literature, besides conducting the more general correspondence.

STATE REPORTS.

Numerous items of interest in the report of the State directors are incapable of tabulation or are peculiar to a particular State, and at the same time are important to a complete record and understanding of the progress of the institute work as it develops each year. In order that the great body of institute workers may be familiar with this progress, the principal points are incorporated in the following accounts under the respective names of the States and Territories:

ALABAMA.

Institute director.—C. A. Cary, professor of veterinary science, Auburn.

The Alabama Polytechnic Institute appropriated all the money expended for farmers' institutes in the State, which amounted to \$600, besides giving the services of the director and 12 members of the college and station staff, which is equivalent to about \$600 additional. No local speakers were used, but two lecturers were usually sent to each institute, which were all one-day meetings. There were, in all, 71 sessions, with a total attendance of 3,555. At each institute the preparation for the coming of the boll weevil, tick eradication, and live stock were discussed. The places, dates, and programs of the institutes are arranged for by the director, who endeavors to maintain an order of rotation. In addition to the institutes held by the Polytechnic Institute, the State department of agriculture conducted a series of meetings under an act of 1907 making an appropriation of \$4,000 for institute purposes. The expenditure of this sum is wholly in the hands of the commissioner of agriculture.

ALASKA.

Institute director.—C. C. Georgeson, special agent in charge of agricultural experiment station, Sitka.

No report was received from the agent in charge.

ARIZONA.

Institute director.—R. W. Clothier, professor of agriculture, Tucson.

With the more liberal appropriation from the State treasury over twice as many sessions of regular institutes were held this year as last. Besides 75 sessions of regular institutes, with an attendance of 3,647, the institute organization also held short courses at a number of high schools. A four-weeks' course was held in the high school of Thatcher and a two-weeks' course at the high schools of Mesa and at Tempe and at two high schools in the Salt River Valley. A two-weeks' series of strong institutes held in the same valley has placed the institute work there on a firm foundation. The cooperation of the Mormon Church was again secured, and the work proved to be more popular than ever before. It should be noted that the evening sessions of the short courses at the high schools were attended almost entirely by farmers. The total attendance at all the day sessions of the short courses held at the high schools was 4,500 and the total attendance at the night sessions 1,100, which, together with the 3,647 in attendance at the regular institutes, makes a grand total of 9,247 for all forms of work done under the institute organization. There was expended for all the above purposes the sum of \$989.93.

ARKANSAS.

Institute director.—George A. Cole, superintendent of farmers' institutes, Fayetteville.

Over one-half the biennial appropriation of \$8,000 for institutes was expended during the year. This \$4,500, however, included the salary and expenses of the director, who has divided the State into four parts and endeavors to expend one-fourth the appropriation in each part. The experiment station furnished 6 lecturers and the agricultural college 5 more, the total of 11 speakers contributing 400 days' services to the institute work. The number of sessions of regular institutes held was 90 and the attendance 32,000, while in addition there were 10 independent institutes held at fairs and picnics, with 15,000 in attendance. and a pure-seed train, which attracted 1,000 more.

CALIFORNIA.

Institute director.—W. T. Clarke, professor of horticulture, Berkeley.

Institutes were held during the year in 32 out of the 58 counties in the State and consisted of 297 sessions, with an attendance of 29,108. In addition, a round-up institute, consisting of six sessions, had an attendance of 3,600, and a special basket picnic institute held at the university farm at Davis had an attendance of 2,400, and an agricultural and horticultural demonstration train, furnished by the Southern Pacific Co., consisting of 9 cars, was run for 68 days, covering 5,674 miles, during which it made 223 stops and attracted 73,663 visitors. That this demonstration train has accomplished good results is already apparent by the increased interest in scientific work along agricultural lines and by the increase in the number of inquiries received. The young people of the State are being interested in the planting and care of trees and shrubs through definite assistance and work with the schools, and nature study and school-gardening work is also receiving increased attention. The institute director reports:

We have placed in the season past strong emphasis on the special-purpose institutes and we find that these special-purpose institutes are of very considerable value, inasmuch as they permit a complete thrashing out of the subject that happens to be under discussion. Our people have got now so that they object to the hit-or-miss institutes and demand the institute that confines itself to one, or, at the most, two topics.

There was expended for all forms of the above work the entire State appropriation of \$10,000 for the year. Ten lecturers from the agricultural college and experiment station devoted a total of 134 days' service to this work. Fifteen State lecturers were also employed, and 183 local speakers made addresses.

COLORADO.

Institute director.—C. H. Hinman, director of farmers' institutes, Fort Collins.

Boys' and girls' agricultural clubs have just been inaugurated as a part of the institute work, and 96 sessions were held, with an attendance of 3,740. The regular institutes consisted of 165 sessions, at which 30,560 were in attendance. A railroad potato special institute train traveled 1,700 miles, making 31 stops, and was visited by 4,850 persons. In addition, there was held one five-day housekeepers' short course, with an enrollment of 215, and one six-day farmers' short course, with an enrollment of 115. No local speakers addressed the institutes. The annual appropriation of \$5,000 for this work was practically all expended.

CONNECTICUT.

Institute director.—I. C. Fanton, secretary State board of agriculture, Westport.

With no special appropriation for institute work, the several State agricultural associations collectively succeeded in holding institutes in every county in the State, consisting of a total of 82 sessions. The secretary of the State board of agriculture reports:

We have what we call the advisory board of institute work consisting of the secretaries of the different agricultural associations of the State with a secretary of the board of agriculture as chairman. This board meets and arranges the meetings so that dates and speakers will not conflict. An appropriation was made to each association to use as it sees fit, but no appropriation specially for institutes was made. In my opinion, we need less talk and more demonstration work. I would like to see a demonstration farm in every county in the State.

DELAWARE.

Institute director.—Wesley Webb, secretary of the board of agriculture, Dover.

Of the 83 sessions of regular institutes with a total attendance of 10,680, it should be noted that 39 sessions with an attendance of 4,850 were women's institutes. Thus, the women's institutes in this State were practically equal in number and in attendance to those for men and were reported as successful. The State made an appropriation of \$600 for institute work, but the State board of agriculture has supplemented this fund by an appropriation from its own funds to the amount of \$577.50, thus bringing the total expense for institute work up to \$1,177.50. Three lecturers from the experiment station contributed 18 days' service, the remainder of the work being done by 15 State speakers and 9 local.

FLORIDA.

Institute director.—P. H. Rolfs, director of the agricultural experiment station, Gainesville.

Marked improvement has been produced during the past two years in regard to better farming, and a large share in this result has been attributed to the farmers' institute, which held this year 122 sessions, at which the attendance was 9,021, at a cost of but \$4,384.03 to the State. One State lecturer was employed continually, and between 30 and 40 local speakers addressed the meetings, while the agricultural college and the experiment station contributed the services of 11 persons, who gave in all 386 addresses. About 20 boys' sessions were held with an attendance above the average for the other sessions. The dates, places, and programs for the institutes are determined jointly with the local people. Corn and the preparation of the soil were discussed at each institute. The varied lines of agriculture and the sparseness of the population make institute work difficult.

GEORGIA.

Institute director.—A. M. Soule, president State college of agriculture, Athens.

Itinerant or movable schools of agriculture have just been inaugurated, as well as boys and girls' farm-life clubs. Of the former, 14 were held during the year, consisting of 100 sessions, and had an attendance of approximately 9,000. Twenty-four sessions for boys were held in the regular institutes, and the attendance was 9,207, of which 3,000 were enrolled in club work. Ninety-four cooperative institutes, with an attendance of 13,837, 10 sessions of round-up institutes, with 500 in attendance, as well as 63 teachers' institutes, with an attendance of 6,665, were held besides the regular institutes, which amounted to 64 sessions, with an attendance of 12,000. The sum of \$2,500 was expended for institute work, exclusive of salaries, which, if added, would bring the total cost up to \$7,500. About 60 local speakers addressed the meetings, and 15 lecturers from the college of agriculture contributed a total of 120 days' service. The local authorities are consulted in regard to dates, places, and programs of the meetings.

HAWAII.

Institute director.—William Weinrich, secretary and treasurer farmers' institutes, Honolulu.

No report received.

IDAHO.

Institute director.—W. L. Carlyle, director agricultural experiment station, Moscow.

With an appropriation of \$2,000 and the services of 9 members of the agricultural college and experiment station, 149 sessions of regu-

lar farmers' institutes were held, with 11,500 in attendance. In addition to the above, there were 17 special institutes, consisting of educational programs at fairs, farm unions, agricultural conventions, etc., the attendance at which was not recorded. These are regarded as giving the best hold on the agricultural public and not only reach a large audience but a higher class of instruction is given. Six institutes for women were also held during the year. Post-card invitations have been found to be the most satisfactory method of advertising the meetings, which were more numerous and attracted a larger attendance than during any previous year.

ILLINOIS.

Institute director.—H. A. McKeene, secretary of the farmers' institute, Springfield.

The State of Illinois makes two separate appropriations for institute work, one for the purpose of holding county farmers' institute meetings in each county, and one for office expenses, administration, etc., and for holding the annual State meeting. These two appropriations combined amount to \$21,650. Again, many county boards of supervisors appropriate funds for assisting the work in their counties, and this added \$4,965 to the regular State appropriation for institute work. Besides the above, many merchants, interested farmers, and others contributed to the county institutes, so that there was actually spent, in addition to the other funds mentioned, \$17,853.23 which came from these private sources, making the total actual cost of the farmers' institute work for Illinois this year \$44,468.23. Every county in the State held at least one institute. The total number of sessions of regular institutes was 792, and the attendance 231,732. The agricultural college and experiment station furnished 36 lecturers, with a combined total of 369 days of service. Thirty State lecturers were employed, and many local persons addressed the meetings. There were also 8 sessions of round-up institutes, with 8,000 in attendance. Besides the above, there were also held boys' camp schools and picnics, and special seed and soil trains were run, but no record was kept of the attendance at these. No special women's institutes were held, but nearly every meeting was planned for the benefit of women as well as men, and almost always there were women on the program. The dates, places, and programs are arranged for by the superintendent and county institute officers at the district conference held in April and June each year. Every county in the State has an institute organization and the one-day meeting has been adopted by most of them. Fifty thousand copies of the annual report of the farmers' institute are now published.

INDIANA.

Institute director.—W. C. Latta, professor of Agriculture, Lafayette.

Each county in the State has an institute organization, and \$100 from the county funds is available for institute work in each county, provided a like sum is raised by membership dues. There was thus contributed from the county treasuries about \$3,120, and from private sources, such as membership dues, donations, etc., about \$7,665, which, together with the State appropriation of \$10,000 annually, made the total amount expended for farmers' institutes this year about \$20,785. Farmers' institutes were held in every county in the State, and the total number of sessions of regular institutes was 1,218, and the attendance 203,910. The college of agriculture and the experiment station contributed the services of 16 lecturers, with an aggregate of 81 days, and 42 State speakers were employed, while about 50 local persons made addresses. No record was kept of the number and attendance at special institutes, the railroad specials, or picnics, as these are not under the farmers' institute auspices in this State. Several women's sessions and 20 sessions for young people were held and the interest reported as good.

IOWA.

Institute director.—J. C. Simpson, secretary board of agriculture, Des Moines.

At a cost of \$14,764.25 the State board of agriculture in cooperation with the extension department of the college of agriculture held 564 sessions of regular farmers' institutes at which 117,550 persons were in attendance. They were distributed in 81 of the 99 counties in the State. Some institutes for women and some sessions for boys were held, but no record was made. The extension department of the college of agriculture furnished the lecturers for all the institutes.

KANSAS.

Institute director.—J. H. Miller, superintendent farmers' institute work and agricultural extension, Manhattan.

The farmers' institute work is carried on as a part of the agricultural education extension work of the college of agriculture, and this year included, besides 782 sessions of regular institutes held in 100 of the 105 counties of the State, with an attendance of 10,044, a number of domestic-science movable schools, at which 372 were reported, many schoolhouse campaigns with 5,672 in attendance, numerous civic-improvement meetings with 21,670 listeners, and agricultural trains that attracted 9,887 people. All the above forms of institute work cost \$25,366.66. Seven persons were employed regularly on the staff and 31 State lecturers part of the time, while 16 members of the

experiment-station staff devoted a total of 103 days to the work, and more than 1,600 local persons addressed the meetings.

KENTUCKY.

Institute director.—M. C. Rankin, commissioner of agriculture, Frankfort.

Better farming, increased yield, and live stock were discussed at each institute, at least one of which was held in every county and consisted in the aggregate of about 476 sessions with an attendance of 18,467. Besides these meetings there were 8 sessions of a State institute with an average of 250 at each session. Ten State lecturers were employed, a number of local speakers used, and 5 lecturers from the staff of the experiment station contributed considerable time to the work, which was carried on at a cost of \$9,016.97.

LOUISIANA.

Institute director.—Charles Schuler, commissioner of agriculture, Baton Rouge; W. R. Dodson, director of the agricultural experiment station, Baton Rouge.

While no farmers' institutes were carried on under the State department of agriculture, and no regularly organized farmers' institute work recognized as such was conducted by the college of agriculture or the experiment station, nevertheless there was considerable work done by the director of the experiment station and the members of the agricultural college and experiment-station staffs that should properly be classed as institute work. Five members of the college of agriculture and the experiment station devoted in all a total of 148 days in which addresses or demonstrations were given to 148 miscellaneous farmers' meetings, at which an aggregate attendance of 20,530 were reported. The services of two women were secured to give addresses on domestic science and school improvement.

MAINE.

Institute director.—A. W. Gilman, commissioner of agriculture, Augusta.

More demonstration work is being introduced into the institutes than heretofore. The places at which institutes will be held are determined by a local agent, and the date and program of the meeting are arranged by the commissioner of agriculture. The law requires two institutes to be held in each county. Two thousand three hundred dollars was expended in holding 107 sessions of regular institutes, with an attendance of 14,831, and four independent institutes at which 327 attended. Six members of the college of agriculture spent a total of 10 days in institute work, while the State employed 12 speakers and 25 local.

MARYLAND.

Institute director.—R. S. Hill, director farmers' institutes, Upper Marlboro.

A large part of the institute work was done with a car owned by the institute and equipped for giving instruction of an institute nature, although in many instances the actual lectures and instruction were given at some distance from the car. There were also a train and a boat special. Four women's institutes were held. In all there were 175 sessions, with a total of 9,151 people in attendance. The total cost was \$6,000. Sixteen State speakers were employed, and 17 local persons addressed the meetings. The college of agriculture and experiment station contributed the services of 4 persons for an aggregate of 26 days.

MASSACHUSETTS.

Institute director.—J. L. Ellsworth, secretary State board of agriculture, Boston.

Institutes were held in every county, aggregating 192 sessions, with a total attendance of 26,304, besides the demonstration meeting, at which there were 1,100 people. The college of agriculture and the experiment station provided 17 lectures and 12 local speakers addressed the meetings. The total cost was \$2,130.37.

MICHIGAN.

Institute director.—L. R. Taft, superintendent farmers' institutes, East Lansing.

Twelve thousand five hundred copies of the annual report of farmers' institutes are published and distributed to the members of the county institute societies. All but five counties held institutes last year, aggregating 1,136 sessions, and attended by 149,602 people. Besides the regular institutes there were 10 sessions of round-up institutes with 4,290 in attendance, and special institute trains were run for 16 days, making 98 stops and attracting 11,039 people. The total cost of the institute work for the year was \$8,500. The college of agriculture furnished 10 lecturers for an aggregate of 50 days and the experiment station 3 lecturers for a total of 15 days. Thirty State speakers were employed and 300 local speakers addressed the meetings.

MINNESOTA.

Institute director.—A. D. Wilson, superintendent of farmers' institutes, St. Anthony Park.

A new feature introduced this year was a good-seed exhibit at most institutes. Business men of different towns donated from \$50 to \$100 for premiums. Special emphasis was laid on good-seed corn. Between 30 and 40 towns have already promised to furnish premiums

for next year. As the farmers' institute work is a part of the agricultural education extension division of the agricultural college, all kinds of special meetings have been classed as extension work, farmers' institutes being now confined to the holding of regular institute meetings. There were 639 sessions of these regular institutes held during the year, at which 100,723 persons were in attendance. Thirty-seven women's institutes were held during June in connection with the regular institutes. Four lecturers from the college of agriculture and experiment station contributed a total of 20 days to the institute work, and 22 State lecturers were employed. The total expenditure for this phase of extension work was \$21,641. Fifty thousand copies of the annual report of the institutes are published and a copy given to every family represented at each institute.

MISSISSIPPI.

Institute director.—W. L. Hutchinson, director farmers' institutes, Agricultural College.

With an expenditure of \$5,000, not including the salary of the director, they were able to hold 243 sessions of regular institutes, with an attendance of 31,199 people, 16 independent institutes, with 3,000 in attendance, and 9 sessions of a round-up institute at which there were 1,000 persons, besides introducing new work by the holding of a number of short courses with agricultural high schools, dairy short courses, and the sending of a trained man to show farmers how to terrace hill land and drain bottom land. In other words, this trained man was in reality an itinerant instructor, employed and sent out by and under the direction of the institute organization to give certain advice to the farmers on their farms. There is already a great demand for expert assistance of this character, and it has proved to be the best plan of disseminating agricultural information to the farmer most in need of assistance.

MISSOURI.

Institute director.—T. C. Wilson, secretary State board of agriculture, Columbia.

During the year there were held 194 sessions of regular institutes, with an attendance of about 14,550, and 12 sessions of round-up institutes, with 1,000 in attendance, while three special trains and a number of chautauquas, picnics, reunions, harvest home meetings, increased the attendance by about 35,000. Women's institutes were held in connection with 20 of the regular institutes. The college of agriculture supplied 10 lecturers for a total of 190 days, and the experiment station sent 10 lecturers for a total of 80 days, while 18 State lecturers were employed, no local speakers being used. The total cost of the institutes, including salary and expenses of the director, was \$6,143.41.

MONTANA.

Institute director.—F. S. Cooley, director farmers' institutes, Bozeman.

At least one farmers' institute was held in every county in the State. Among new features for Montana institutes this year were a movable school, 2 special trains, 3 school lectures, and 4 boys and girls' corn-growing contests. The special train attracted 7,292 people, and the 2 special institutes had a total attendance of 1,600. There were 148 sessions of regular institutes, with an attendance of 17,870. The total cost of all these institutes was \$8,000, which includes the salary and expenses of the director. Several State speakers were employed, a number of local speakers made addresses, and 13 lecturers from the college and station contributed a total of 85 days' service.

NEBRASKA.

Institute director.—Val Keyser, superintendent of institutes, Lincoln.

Sixteen different State societies met at the university farm the third week in January and held their annual meeting under the caption of organized agriculture. About 1,800 people attended this meeting, which was practically a round-up institute. Of the regular institutes there were 578 sessions, with an attendance of 104,519. At 9 of these boys' sessions were held with good success, and 27 boys' and girls' special institutes were also held, with 6,995 in attendance. There was increased interest in women's work, and the attendance at the women's sessions was often greater than those for men. There were also 6 short courses or movable schools, with a total registration of 1,200, not including 785 boys and girls for whom special classes were organized. The total cost of the institutes was \$16,776.25, of which amount \$10,000 was State appropriation. Sixteen college and station lecturers devoted a total of 93 days to the work. The State lecturers numbered 31.

NEVADA.

Institute director.—J. E. Stubbs, president Nevada State College, Reno.

No institutes were held.

NEW HAMPSHIRE.

Institute director.—N. J. Bachelder, secretary State board of agriculture, Concord.

During the year 18 days were devoted to farmers' institutes, which consisted of 36 sessions, with an attendance of 3,000. The cost to the State was \$1,200. The college of agriculture contributed 1 lecturer to each meeting, and 18 local speakers addressed the institutes, while 10 State speakers were employed.

NEW JERSEY.

Institute director.—Franklin Dye, secretary State board of agriculture, Trenton.

Including the regular institutes, the annual meeting, and also farmers' week, there were held during the year 116 sessions, with a total of 11,000 in attendance. In addition, there were railroad specials on three roads, covering in all 6 days, and meeting 2,000 people. The agricultural college supplied 6 lecturers for a total of 35 days, while 4 State lecturers and 3 local speakers were used. In all, \$2,976.49 was expended in the work.

NEW MEXICO.

Institute director.—Luther Foster, dean of agriculture, Agricultural College. No farmers' institutes were held during the year.

NEW YORK.

Institute director.—R. A. Pearson, commissioner of agriculture, Albany.

New York State appropriated for institutes for the year \$31,000, and \$27,500 was expended, which, however, does not include the salary and expenses of the director. There were held during the year 1,170 sessions of regular institutes, with an attendance of 149,450. In addition, there were held 156 periods in public schools, at which a total of 22,697 were present, this school work being a feature of the institutes in this State. There were also 8 institutes in cooperation with State agricultural organizations, in which the attendance amounted to 23,750. One woman speaker accompanied each institute force, and special women's sessions were held at several institutes. One normal institute and 28 summer institutes were held. The institute also cooperated with the college of agriculture and the railroads in running 3 farm trains. A new feature of the institute work this year was the introduction of field demonstrations. One man was employed in this work, who installed 100 fields of alfalfa. The college of agriculture furnished 15 lecturers for a total of 50 days, the experiment station 10 lecturers for 120 days, and the State employed about 35 lecturers.

NORTH CAROLINA.

Institute director.—T. B. Parker, director of farmers' institutes, Raleigh.

Thirty-five thousand copies of the annual report of the institute work are published and distributed to the regular mailing list. The State appropriation of \$7,500 for the year was all expended in holding 469 sessions of regular institutes, at which 40,604 people were in attendance; 14 independent institutes, with a total attendance of 2,250; 9 sessions of round-up institutes, with 1,800 present; and 73

women's institutes, the attendance at which is not reported. The college of agriculture furnished 4 lecturers for a total of 59 days, the experiment station 2 for a total of 44 days, and the institute employed 10 lecturers for a total of 374 days.

NORTH DAKOTA.

Institute director.—T. A. Hoverstad, superintendent of farmers' institutes, Fargo.

Grain growing, forage crops, cultivation, and grasses were subjects discussed at each meeting. A copy of the institute annual is given to each family attending the first session, 15,000 copies being published. The State appropriated for institute work \$6,000, but the institute actually cost \$10,417.81, the difference being made up by some funds left over from previous years. There were 243 sessions of regular institutes, with an attendance of 31,606; 4 independent institutes, with 12,075 in attendance; and better-farming special trains consisting of 6 cars with illustrative and demonstrative material, which attracted 19,200 people. The college of agriculture and the experiment station contributed the services of 8 lecturers for a total of 15 days at the regular institutes and 14 lecturers for a total of 281 days at the special-train institute. Only three State speakers were employed.

OHIO.

Institute director.—A. P. Sandles, secretary State board of agriculture, Columbus.

Twenty thousand two hundred and fifty dollars of the State appropriation of \$22,000 for institutes was expended, but this does not include the salary and expenses of the director. The State employed 36 lecturers and made use of 1,800 local speakers, while the experiment station furnished 20 lecturers for an aggregate of 195 days. The number of sessions of regular institutes was 1,620 and the attendance 421,040, while in addition there were 51 independent institutes, with 12,705 in attendance, 5 sessions of round-up institutes with 500 people, and a number of orchard schools, corn schools, and dairy, fruit, and corn trains, the attendance at which is not recorded.

OKLAHOMA.

Institute director.—J. S. Murray, superintendent of farmers' institutes, Guthrie.

Twenty thousand copies of the annual institute report are printed and distributed at the institutes. Boys' and girls' work and women's auxiliaries were introduced this year as new work. There was appropriated by the State as a whole \$5,000 for institute work, and by the counties \$15,200 additional, making \$20,200 for institute work

of all kinds. The State department, however, expended \$6,500, which was \$1,500 more than was appropriated, and hence if every county expended all its appropriation the total expenditure for institute work during the year from all sources would amount to \$21,700. Seven hundred and forty sessions of regular institutes with an attendance of 80,000 are reported, besides 204 independent institutes with 60,000 in attendance, and 6 sessions of round-up institutes with 2,400 in attendance. In addition institute picnics were held at the demonstration farms in 67 counties with an estimated attendance of 21,775. About 40 counties have women's organization auxiliary institutes. Boys' sessions were held in 30 institutes. No State lecturers were employed, the college of agriculture and the experiment station furnishing all the speakers and paying the salaries. Seventy-six local people addressed the meetings. Five members of the agricultural college spent a total of 150 days in institute work, and three from the experiment station about 90 days.

OREGON.

Institute director.—J. Withycombe, director agricultural experiment station, Corvallis.

Swine husbandry and horticulture were the principal topics discussed at all institutes. The institute is also assisting at fairs by judging live stock and farm products, and lecturing upon the strong and weak points of the exhibit. This has proved to be effective educational work. Demonstration work also has been made a feature of practically all institutes. The State appropriation of \$2,500 enabled the holding of 64 sessions of regular institutes with an attendance of 11,250. Two demonstration trains were run, consisting of 7 cars filled with demonstration material. The trains made 36 stops and met 1,635 people. Four State lecturers were employed besides 80 local speakers. The college of agriculture sent 1 lecturer for 10 days, and the experiment station 9 lecturers for a total of 170 days of institute work.

PENNSYLVANIA.

Institute director.—A. L. Martin, deputy secretary of agriculture, Harrisburg.

Twelve movable schools, lasting from 4 to 8 days each, were held and interested the people, especially in the more advanced communities, along special lines of agriculture, such as dairying, horticulture, and poultry industry. The total attendance at these schools was 16,697. The demonstration method of instruction has been a prominent phase in these schools. In all the regular institutes the subjects of dairying, horticulture, poultry, and home sanitation were discussed. One thousand and sixty-one sessions, with an attendance of 161,696, were reported, besides 17 independent institutes, with an

attendance of 16,679; 11 sessions of round-up institutes, with 2,000 in attendance, and numerous special institutes and cooperative meetings, picnics, railroad specials, etc., with a reported combined attendance of 31,520. There were 150 women's sessions in connection with the regular institutes, or one in nearly every two-day institute held. The institute work cost \$20,000, which, however, does not include the salary and expenses of the director. There were 69 lecturers employed, and 282 local speakers addressed the meetings. The agricultural college and experiment station contributed 10 lecturers for a total of 70 days.

PORTO RICO.

Institute director.—D. W. May, special agent in charge of the agricultural experiment station, Mayaguez.

Seven lecturers from the experiment station and 1 from the agricultural college contributed a total of 45 days to institute work; 9 sessions of regular institutes, with an attendance of 420, and 3 independent institutes, with an attendance of 1,500, were held, at a total cost of \$200.

RHODE ISLAND.

Institute director.—J. J. Dunn, secretary State board of agriculture, Providence.

There were held during the year 22 sessions of regular institutes, with an attendance of 2,910, and 4 sessions of a round-up institute, with 1,200 in attendance, at a total cost of \$266.60. There were employed 16 State lecturers and 10 local speakers. Six members of the agricultural college and experiment station donated a total of 7 days to the work. In connection with the institutes on fruit growing there were demonstrations in spraying for the San José scale and other injurious insects.

SOUTH CAROLINA.

Institute director.—D. N. Barrow, professor of agriculture, Clemson College.

No special State appropriation was made for institutes, but the college of agriculture carried on the work at a cost of \$1,141.68. Nine State lecturers were employed. Four members of the college faculty, and 4 members of the experiment station staff devoted 30 days to the work, which consisted of 265 sessions of regular institutes, with 9,000 in attendance, and 60 independent institutes, with an attendance of 5,000. At two points the institute lasted a week, and regular class work was given.

SOUTH DAKOTA.

Institute director.—A. E. Chamberlain, superintendent of institutes, Brookings.

Soil moisture and corn and crop rotation were subjects discussed at every regular institute, of which there were 368 sessions, with an

attendance of 48,500. There were also about 25 independent institutes, attended by 3,000 people. One women's institute was held, but lady speakers on the regular force addressed 63 institutes. Three large meetings for boys and girls were held. The total expense of the institutes was \$10,183.79. The State employed 15 lecturers and the college of agriculture and the experiment station contributed 3 lecturers for a total of about 20 days.

TENNESSEE.

Institute director.—John Thompson, commissioner of agriculture, Nashville.

With the exception of 19 local speakers the institute work was done solely by the 8 members of the experiment station staff, who devoted a total of 43 days to the work. Four short courses or movable schools were held in different places, lasting from 5 to 10 days, with 2 sessions each day, and with a total registration of 413. Forty-six sessions of regular institutes were held, with an attendance of 8,910, and 24 sessions of round-up institutes, with 5,500 in attendance. In addition an agricultural train was run, which was attended by 1,095 persons. The total expense for the year was \$3,753.67, although the State appropriated \$5,000 for the work.

TEXAS.

Institute director.—J. W. Neill, director of farmers' institutes, Austin.

This report covers the first institute work done in the State under a definite appropriation, \$5,000 having been given for the work this year. Diversified and intensified farming was discussed at all institutes. About 10 State lecturers were employed, and the college of agriculture and experiment station furnished 6 lecturers for a total of 69 days. About 240 sessions of regular institutes were held with an attendance of 3,238. There were also two sessions of round-up institutes, but no record was kept of the attendance, nor was any record kept of the railroad special demonstration train statistics.

UTAH.

Institute director.—L. A. Merrill, director agricultural extension, Logan.

Ten thousand copies of the annual report of the institute work is published each year and distributed to the experiment station mailing list. The cost of the institutes was \$6,442.35, which was \$611.95 more than the State appropriated, the difference being made up by the fees received from farmers' schools. There were five State lecturers employed part of the time, but the bulk of the institute work was done by the college of agriculture and the experiment station, the former furnishing 4 lecturers for a total of 240 days, and the latter 10 lecturers for a total of 540 days. There were 240 sessions of regular

institutes with 29,573 persons in attendance. A special potato train was run with an attendance of 2,161. Fourteen women's institutes were also held, consisting of 63 sessions.

VERMONT.

Institute director.—O. L. Martin, commissioner of agriculture, Plainfield.

Agricultural education in the public schools was a subject discussed at every institute, and the employing of institute lecturers from without the State was a new feature of the work in Vermont. Nine State lecturers were employed, and two members of the agricultural college and experiment station devoted an aggregate of 15 days to the work. The cost of the institutes was \$1,200, and 65 sessions of regular institutes were held with 5,190 in attendance, and 6 independent institutes with 1,000 people. There were also 13 sessions of round-up institutes which had 300 in attendance, and a railroad special attended by 5,900 people.

VIRGINIA.

Institute director.—J. J. Owen, director of institutes, Richmond.

Under an act of the legislature approved March 17, 1910, a board to be known as the United Agricultural Board was established, composed of the governor, the State superintendent of public instruction representing the State board of education, the commissioner of agriculture and two members of the State board of agriculture to be selected by that board, the president of the Virginia College of Agriculture and Polytechnic Institute, the director of the Virginia Agricultural Experiment Station, and one member of the board of visitors of these institutions to be selected by the said board, the supervisor of the district experiment stations, the general director of demonstration work of the United States Department of Agriculture, and the Virginia director of demonstration work of the United States Department of Agriculture.

Under this act the United Agricultural Board is required to assign to the Virginia College of Agriculture and Polytechnic Institute the adult demonstration work and movable schools and other like agencies when established; to the Virginia Agricultural Experiment Station the establishment and direction of the local or district experiment stations; to the State board of education the experiment and demonstration work in connection with the public schools of the State; and to the commissioner and the State board of agriculture the direction and management of the farmers' institutes to be held in different sections of the State.

In carrying the bill into effect the State board of education is directed to appropriate and set apart out of the common-school fund the sum of \$5,000 annually to supplement money allotted by the

United States Department of Agriculture and the general education board. The sum of \$5,000 shall be paid annually to the commissioner of agriculture, the sum of \$5,000 annually to the Virginia College of Agriculture and Polytechnic Institute, and the sum of \$5,000 annually to the Virginia Agricultural Experiment Station. The money allotted to the commissioner of agriculture shall be used for farmers' institutes, the money allotted to the Virginia College of Agriculture and Polytechnic Institute shall be used for adult demonstration work, movable schools, etc., and the money allotted to the Virginia Agricultural Experiment Station shall be used for experiment work at the local or district experiment stations, established or to be established, and for no other purpose, and the money appropriated by the State board of education shall be used for experiments and demonstrations in connection with the schools of the State. During the past year \$4,000 was expended for institute work. Two hundred and thirty-six one-day institutes were reported as having been held with a total attendance of 22,000 persons.

WASHINGTON.

Institute director.—R. C. Ashby, superintendent of institutes, Pullman.

Three demonstration trains were run, which made in all 28 stops and were attended by 9,345 people. These trains consisted of from 7 to 9 coaches carrying complete equipment, consisting of live stock; field, orchard, and tillage machinery; pruning tools; spraying machines; dairying outfits; milking machine; farm electric-light plant; cement demonstration equipment; horticultural, entomological, grain, forage-crop, and grass exhibits. The train was furnished by the railroad company, the machinery was loaned by the manufacturers, and the exhibits and speakers were furnished by the agricultural college. Of regular institutes there were 177 sessions, with an attendance of 14,083; 6 independent institutes, with 1,200 in attendance; and 7 sessions of grange meetings, with 545 people. The total cost for the institute work was \$6,900. Fifteen State lecturers were employed, and two or three and sometimes more local speakers made addresses at each meeting. The college of agriculture furnished 5 lecturers for a total of 68 days, and the experiment station 9 lecturers for a total of 61 days.

WEST VIRGINIA.

Institute director.—Charles McIntire, superintendent farmers' institutes, Charleston.

All the institute work during the year was carried on by 21 State speakers. There were 307 sessions of regular institutes, at which 27,398 persons attended, and one agricultural train, which added

1,328 more to the total number of people reached by the institutes. The entire cost to the State was \$6,630.

WISCONSIN.

Institute director.—George McKerrow, director farmers' institutes, Madison.

The institute published 50,000 copies of its 320-page annual farmers' institute bulletin, and 10,000 copies of a 96-page cook book, and distributed them to the institutes and cooking schools.

The law requires that one copy of the annual shall be placed in each school district library, and this alone consumed about 8,000 copies. These annual farmers' institute bulletins are the most popular publications along agricultural lines published by the State, and the demand for them exceeds the supply. Bovine tuberculosis, alfalfa, roads, and soil fertility were subjects discussed at each institute. There were altogether 660 sessions of regular institutes, with an attendance of 100,519; 9 sessions of round-up institutes, with about 7,130 persons in attendance; and 41 cooking schools. Thirty State lecturers and about 20 local speakers were employed. The agricultural college and experiment station furnished 5 lecturers for a total of 6 days. The total cost of the institutes was \$20,000, which includes the salary and expenses of the director and the printing and distributing of the annual bulletin and the cook book.

WYOMING.

Institute director.—H. G. Knight, director agricultural experiment station, Laramie.

The institutes for the year cost the State \$1,737.54, which enabled the holding of 98 sessions of regular institutes, with an attendance of 4,108, and 19 sessions of a railroad special, with 3,700 in attendance. The agricultural college and experiment station furnished 12 lecturers for a total of 257 days, and 15 additional State lecturers were employed.

STATISTICS OF FARMERS' INSTITUTES, 1910.

Number of institutes held and the approximate attendance during the year ended June 30, 1910.

State or Territory.	Number of one-day institutes.	Number of two-day institutes.	Number of three or more day institutes.	Total.	Total number of sessions.	Total attendance at all sessions.	Average per session.
Alabama.....	31	.....	.....	31	71	3,555	50
Alaska ¹.....	.....	.....	.....	.....	.....	.....	.....
Arizona.....	41	2	.....	43	75	3,647	49
Arkansas.....	85	3	2	90	90	32,000	355
California.....	73	25	2	100	297	29,108	98
Colorado.....	73	4	3	80	165	30,560	185
Connecticut.....	50	4	1	55	82	(²)	(²)
Delaware.....	24	7	.....	31	83	10,680	129
Florida.....	59	3	1	63	122	9,021	74
Georgia.....	27	3	.....	30	64	12,000	187
Hawaii ¹.....	.....	.....	.....	.....	.....	.....	.....
Idaho.....	29	20	2	51	149	11,500	77
Illinois.....	65	50	48	163	792	231,732	292
Indiana.....	184	165	5	354	1,218	203,910	167
Iowa.....	.....	43	40	83	564	117,550	208
Kansas.....	154	93	.....	247	782	10,044	13
Kentucky.....	.....	119	1	120	476	18,467	38
Louisiana.....	148	.....	.....	148	148	20,530	139
Maine.....	53	1	.....	54	107	14,831	138
Maryland.....	75	18	.....	93	175	9,151	52
Massachusetts.....	137	.....	.....	137	172	23,664	138
Michigan.....	328	71	4	403	1,136	149,002	131
Minnesota.....	227	38	1	266	639	100,723	157
Mississippi.....	135	2	.....	137	243	31,199	128
Missouri.....	61	34	2	97	194	14,550	75
Montana.....	72	5	2	79	148	17,870	120
Nebraska.....	33	124	.....	157	578	104,519	181
Nevada ¹.....	.....	.....	.....	.....	.....	.....	.....
New Hampshire.....	18	.....	.....	18	36	3,000	83
New Jersey.....	31	5	2	38	116	11,000	95
New Mexico ¹.....	.....	.....	.....	.....	.....	.....	.....
New York.....	189	110	10	309	1,170	149,450	127
North Carolina.....	268	1	.....	269	469	40,604	87
North Dakota.....	75	13	1	94	243	31,606	130
Ohio.....	.....	324	.....	324	1,620	421,040	259
Oklahoma.....	150	130	.....	280	740	80,000	108
Oregon.....	35	4	1	40	64	11,250	175
Pennsylvania.....	30	160	12	202	1,061	161,696	152
Porto Rico.....	9	.....	.....	9	9	420	47
Rhode Island.....	15	1	.....	16	22	2,910	132
South Carolina.....	25	51	2	78	265	9,000	34
South Dakota.....	31	74	1	106	368	48,500	131
Tennessee.....	22	1	.....	23	46	8,910	193
Texas.....	105	20	5	130	240	3,238	14
Utah.....	18	4	9	31	240	29,573	123
Vermont.....	37	.....	.....	37	65	5,190	79
Virginia.....	236	.....	.....	236	(²)	22,000	(²)
Washington.....	52	5	8	65	177	14,083	79
West Virginia.....	20	64	.....	84	307	27,398	89
Wisconsin.....	.....	132	1	133	660	100,519	152
Wyoming.....	9	2	6	17	98	4,108	42
Total.....	3,539	1,940	172	5,651	16,586	2,395,908	144

¹ No institutes held.

² No report.

Financial statistics of the farmers' institutes for the year ended June 30, 1910.

State or Territory.	Funds appropriated.		Cost.		Appropriation for the season 1911.
	State.	College and other funds.	Total cost.	Cost per session.	
Alabama.....		\$600.00	\$600.00	\$8.45	\$600.00
Alaska ¹					
Arizona.....	\$1,250.00		989.93	13.19	1,386.00
Arkansas.....	4,500.00		4,500.00	50.00	3,500.00
California.....	10,000.00		10,000.00	33.67	10,000.00
Colorado.....	5,000.00		4,894.03	29.66	(²)
Connecticut ²					
Delaware.....	1,177.50		1,302.50	15.69	³ 600.00
Florida.....	7,500.00		4,384.03	35.94	10,615.07
Georgia.....	7,500.00		7,500.00	117.17	⁴ 2,500.00
Hawaii ¹					
Idaho.....	2,000.00	500.00	2,500.00	16.77	⁴ 2,000.00
Illinois.....	26,615.00	17,853.23	44,468.23	56.15	26,615.00
Indiana.....	13,120.00	7,665.00	20,785.00	17.06	10,000.00
Iowa.....	5,754.11	9,220.43	14,764.25	26.18	7,500.00
Kansas.....	25,000.00	366.66	25,366.66	32.45	27,500.00
Kentucky.....	9,016.97		9,016.97	18.95	(²)
Louisiana.....	2,000.00		2,000.00	13.51	2,000.00
Maine.....	2,300.00		⁴ 2,300.00	21.49	3,000.00
Maryland.....	6,000.00		6,000.00	34.28	6,000.00
Massachusetts.....	4,000.00		2,130.37	12.38	4,000.00
Michigan.....	8,500.00	1,260.00	⁴ 9,760.00	8.59	9,700.00
Minnesota.....	18,000.00	3,765.99	21,641.25	33.86	18,000.00
Mississippi.....	5,000.00	2,000.00	7,000.00	28.80	7,000.00
Missouri.....	6,143.41		6,143.41	31.66	3,856.59
Montana.....	8,000.00		8,000.00	54.00	8,000.00
Nebraska.....	10,000.00	6,776.26	16,776.26	29.02	8,000.00
Nevada ¹					
New Hampshire.....	1,200.00	400.00	1,600.00	44.44	1,200.00
New Jersey.....	3,176.49		3,176.49	27.38	(²)
New Mexico ¹					
New York.....	31,000.00		27,500.00	23.50	25,000.00
North Carolina.....	7,500.00		7,500.00	15.99	(²)
North Dakota.....	6,000.00	4,417.81	10,417.81	42.87	6,000.00
Ohio.....	22,000.00		21,250.00	13.11	22,000.00
Oklahoma.....	20,200.00	1,500.00	21,700.00	29.32	20,200.00
Oregon.....	2,500.00		2,500.00	39.06	2,500.00
Pennsylvania.....	22,500.00		⁴ 20,000.00	18.85	22,500.00
Porto Rico.....		1,000.00	200.00	22.22	(²)
Rhode Island.....	266.60		266.60	12.11	(²)
South Carolina.....		1,141.68	⁴ 1,141.68	4.30	(²)
South Dakota.....	10,000.00	187.22	10,183.79	27.67	10,000.00
Tennessee.....	5,000.00		3,753.67	81.60	5,000.00
Texas.....	5,000.00		4,123.47	17.17	5,000.00
Utah.....	5,830.40	611.95	6,442.35	26.84	4,169.60
Vermont.....	1,500.00		1,500.00	23.07	(²)
Virginia.....	4,000.00		4,000.00	(²)	(²)
Washington.....	8,750.00		6,900.00	38.98	7,300.00
West Virginia.....	6,630.00		6,630.00	21.59	6,000.00
Wisconsin.....	20,000.00		20,000.00	30.30	20,000.00
Wyoming.....	1,000.00	737.54	1,737.54	7.73	(²)
Total.....	372,430.48	59,943.77	415,346.29	25.04	329,242.26

¹ No institutes held.

² No report.

³ State board of agriculture supplements this amount.

⁴ The salaries paid by institution not included.

Number of lecturers employed by the State directors of farmers' institutes, the number of days of institutes held, and the copies of reports of proceedings published for the year ended June 30, 1910.

State or Territory.	Total number of lecturers on the State force.	Number of members of agricultural college and experiment station staffs engaged in institute work.	Number of days contributed to institute work by agricultural college and experiment station staffs.	Total number of days of institutes held during the year.	Reports of proceedings.	
					Published.	Number of copies.
Alabama.....	(¹)	12	(¹)	31	No.....	.....
Alaska ²					No.....	.....
Arizona.....	6	7	103	45	No.....	.....
Arkansas.....	11	11	300	97	No.....	.....
California.....	27	10	134	129	Yes.....	12, 500
Colorado.....	26	37	(¹)	90	No.....	.....
Connecticut.....	44	(¹)	(¹)	61	(¹)	.....
Delaware.....	17	3	18	38	No.....	.....
Florida.....	16	11	193	68	No.....	.....
Georgia.....	20	15	120	33	Yes.....	2, 500
Hawaii ²						
Idaho.....	34	9	113	75	No.....	.....
Illinois.....	44	36	309	309	Yes.....	50, 000
Indiana.....	47	16	81	529	Brief report.....	.....
Iowa.....	21	(¹)	(¹)	206	No.....	.....
Kansas.....	29	19	109	340	No.....	.....
Kentucky.....	17	5	(¹)	241	Yes.....	25, 000
Louisiana.....	9	5	148	148	No.....	.....
Maine.....	20	6	10	55	Yes.....	6, 000
Maryland.....	30	4	26	111	No.....	.....
Massachusetts.....	(¹)	17	(¹)	137	No.....	.....
Michigan.....	50	13	65	482	Yes.....	12, 500
Minnesota.....	20	4	20	306	Yes.....	50, 000
Mississippi.....	23	11	96	139	Yes.....	10, 000
Missouri.....	22	20	270	135	No.....	.....
Montana.....	17	13	85	88	Yes.....	8, 000
Nebraska.....	25	16	93	281	Yes.....	3, 000
Nevada ²	13					
New Hampshire.....	16	1	18	18	Yes.....	1, 500
New Jersey.....	12	6	35	47	Partial.....	.....
New Mexico ²						
New York.....	70	25	170	439	Yes.....	.....
North Carolina.....	47	6	103	270	Yes.....	35, 000
North Dakota.....	12	8	15	114	Yes.....	15, 000
Ohio.....	31	20	195	648	Yes.....	(¹)
Oklahoma.....	15	8	240	410	Yes.....	20, 000
Oregon.....	14	10	180	46	No.....	.....
Pennsylvania.....	75	10	70	386	Record published.....	.....
Porto Rico.....		8	45	9	No.....	.....
Rhode Island.....	19	6	7	17	Yes.....	2, 000
South Carolina.....	9	8	30	133	No.....	.....
South Dakota.....	17	3	20	182	No.....	.....
Tennessee.....	10	8	43	24	Yes.....	5, 000
Texas.....	5	6	69	160	No.....	.....
Utah.....	17	14	780	53	Yes.....	10, 000
Vermont.....	8	2	15	37	Yes.....	10, 000
Virginia.....	11	(¹)	(¹)	236	No.....	(¹)
Washington.....	16	14	129	86	No.....	.....
West Virginia.....	22			148	No.....	.....
Wisconsin.....	24	5	6	267	Yes.....	50, 000
Wyoming.....	14	12	257	31	No.....	.....
Total.....	1, 052	480	4, 780	7, 935		328, 000

¹ No report.

² No institutes held.

Special institutes, including independent, round-up institutes, picnics, fairs and conventions, railroad specials, etc.—Continued.

State or Territory.	Independent institutes.		Round-up institutes.		Picnics, fairs, and conventions.		Movable schools.		Railroad specials.			Field demonstration meetings.		Total attendance.		Women's institutes.		Young people's institutes.	
	No.	Attendance.	No.	Sess.	Attendance.	No.	Attendance.	No.	Sess.	Attendance.	Miles.	No.	Attendance.	No.	Sess.	No.	Attendance.	No.	Sess.
Alabama ¹																			
Alaska ¹																			
Arizona						50	77	5,000											
Arkansas					10	15,000													
California					1	2,400													
Colorado			1	6	3,600	1													
Connecticut ¹							2	11	330	231	1,700							96	3,740
Delaware																			
Florida																13	4,850		
Georgia																			
Hawaii ⁴	3	94	13,837	1	10	500										23,337	1	20	1,480
Idaho																			
Illinois						17										6			
Indiana ²			1	8	8,000														
Iowa																			
Kansas						13	235	48,690											
Kentucky			1	8	2,000			372	1										
Louisiana																			
Maine	4	327																	
Maryland	2	250																	
Massachusetts																			
Michigan			1	10	4,290														
Minnesota																			
Mississippi	16	3,000	1	9	1,000														
Missouri			1	12	1,000														
Montana ³																			
Nebraska	3	950	1	1,800				1,985										27	6,995
Nevada ⁴																			
New Hampshire ¹																			
New Jersey																			
New Mexico																			
New York	8	23,750	1	35															
North Carolina	14	2,250	1	9	1,800														

¹ No report.

² Days.

³ Cooperative institutes.

⁴ No institutes held.

⁵ A normal school for lecturers with an attendance of 147 was held.

⁶ Train stops included in regular institutes.

⁷ Included in regular institutes.

⁸ Two special-subject institutes with an attendance of 1,600 was held.

Special institutes, including independent, round-up institutes, picnics, fairs and conventions, railroad specials, etc.—Continued.

State or Territory.	Inde- pendent in- stitutes.		Round-up in- stitutes.		Picnics, fairs, and conventions.		Movable schools.		Railroad specials.			Field dem- onstration meetings.		Total at- tend- ance.		Women's in- stitutes.		Young people's institutes.				
	No.	Attend- ance.	No. Sess.	Attend- ance.	No.	Attend- ance.	No.	Sess.	Attend- ance.	No.	Stops.	Miles.	Attend- ance.	No.	Attend- ance.	No. Sess.	Attend- ance.	No. Sess.	Attend- ance.			
North Dakota.....	4	12,075								1	33	19,200			31,275							
Ohio.....	51	12,705	1	500											13,205							
Oklahoma.....	204	60,000	1	2,400										67	21,775	40		30				
Oregon.....										2	36	1,635			1,635							
Pennsylvania.....	17	16,679	1	2,000		12,841									31,520	150						
Porto Rico.....	3	1,500													1,500							
Rhode Island.....			1	1,200											1,200							
South Carolina.....	60	5,000					2								5,000							
South Dakota.....	25	3,000													3,000	1						
Tennessee.....			3	24	5,500		4			1		1,508			7,008							
Texas.....			1							1												
Utah.....										1		2,101			2,101	14	63					
Vermont.....	6	1,000	1	300						1		5,900			7,200							
Virginia.....																						
Washington.....	6	1,200								3	28	9,345			10,545							
West Virginia.....										1		1,328			1,328							
Wisconsin.....			1	9	7,130										7,130	41						
Wyoming.....										1	19	3,700			3,700							
Total.....	517	157,523	20	144	43,056	56	30,241	91	423	65,977	29	464	1,700	189,645	69	22,875	444	113	4,850	57	160	21,422

¹ No report.

Comparative statement of farmers' institutes.

State or Territory.	Appropriation.		Number of sessions.		Number of institutes.			Attendance.			
	1907-8	1908-9	1909-10	1908-9	1907-8	1908-9	1909-10	1907-8	1908-9	1909-10	
Alabama.....	\$1,000.00	\$1,400.00	\$600.00	42	71	40	24	31	8,844	4,240	3,555
Alaska ¹											
Arizona.....	1,745.00	123.95	1,250.00	34	75	56	34	43	2,673	1,862	3,647
Arkansas.....	1,500.00	4,635.60	4,500.00	150	90	56	70	90	5,596	44,161	32,008
California.....	8,000.00	7,000.00	10,000.00	250	297	88	93	100	27,912	28,294	23,108
Colorado.....	7,724.46	9,242.42	5,000.00	130	165	126	70	80	38,930	22,560	30,560
Connecticut.....	1,700.00	1,631.97	(¹)	53	82	25	23	35	3,700	(¹)	(¹)
Delaware.....	2,500.00	1,650.00	1,177.50	70	83	19	23	31	4,905	9,210	10,680
Florida.....	2,500.00	2,500.00	7,500.00	56	122	26	29	63	3,316	5,576	9,021
Georgia.....	4,000.00	7,000.00	7,500.00	56	64	40	26	30	12,000	4,480	12,000
Hawaii.....	74.49	(²)	(¹)	(¹)	(¹)	4	(¹)	(¹)	150	(¹)	(¹)
Idaho.....	1,000.00	1,000.00	2,500.00	90	149	12	43	51	5,650	8,560	11,500
Illinois.....	29,540.00	19,043.75	44,468.23	639	792	108	111	163	122,523	82,855	231,732
Indiana.....	18,000.00	20,000.00	20,785.00	1,102	1,218	321	351	354	195,912	215,211	203,910
Iowa.....	7,954.98	10,050.58	14,974.54	415	594	75	83	83	75,000	103,750	117,550
Kansas.....	6,495.51	8,200.00	25,366.66	576	782	176	212	247	33,084	37,191	10,044
Kentucky.....	8,982.85	10,307.44	9,016.97	464	476	132	119	120	21,690	21,538	18,467
Louisiana.....	2,000.00	(¹)	2,000.00	(¹)	148	(¹)	(¹)	148	(¹)	(¹)	20,530
Maine.....	3,000.00	4,500.00	2,300.00	79	107	50	38	54	14,143	8,267	14,831
Maryland.....	6,000.00	6,000.00	6,000.00	97	175	41	56	93	8,903	9,345	9,151
Massachusetts.....	4,000.00	4,000.00	4,000.00	187	172	127	136	137	18,412	20,756	23,664
Michigan.....	8,500.00	8,823.62	9,750.00	1,163	1,136	326	404	406	121,654	147,638	149,602
Minnesota.....	20,544.50	23,560.23	21,705.99	684	639	272	332	266	92,091	109,625	100,723
Mississippi.....	5,000.00	5,000.00	7,000.00	166	243	129	118	137	28,910	25,229	31,199
Missouri.....	5,000.00	8,000.00	6,143.41	705	104	250	260	97	40,000	64,800	14,550
Montana.....	7,500.00	7,500.00	8,000.00	178	148	72	72	79	12,293	20,016	17,870
Nebraska.....	13,617.68	14,795.84	16,776.26	500	578	175	144	157	93,824	86,623	104,519
Nevada ¹											
New Hampshire.....	1,000.00	1,200.00	1,600.00	24	36	16	12	18	2,500	1,800	3,000
New Jersey.....	2,500.00	3,000.00	3,176.49	128	116	37	38	38	10,134	10,425	11,000
New Mexico.....	1,425.00	1,800.00	(¹)	50	(¹)	50	37	(¹)	3,085	1,696	(¹)
New York.....	25,000.00	28,000.00	31,000.00	1,054	1,170	307	276	309	149,418	172,119	140,450
North Carolina.....	7,500.00	6,400.00	7,500.00	514	469	194	234	269	52,978	46,500	40,604
North Dakota.....	6,721.65	9,835.22	10,417.81	281	243	90	107	94	38,000	46,538	31,006
Ohio.....	23,986.15	22,000.00	22,000.00	1,760	1,620	298	352	324	461,515	400,000	421,040
Oklahoma.....	1,285.29	4,800.00	21,700.00	206	740	(²)	72	280	(²)	11,953	80,000
Oregon.....	2,500.00	3,000.00	2,500.00	79	64	32	35	40	7,500	16,930	11,250
Pennsylvania.....	23,000.00	23,000.00	22,500.00	982	1,061	217	203	202	145,353	156,652	161,696
Porto Rico.....	(¹)	400.00	1,000.00	12	9	(¹)	10	9	(¹)	700	420
Rhode Island.....	125.00	487.29	266.60	12	22	15	10	16	1,800	1,400	2,910

¹ No institutes held.² No report.

Comparative statement of farmers' institutes—Continued.

State or Territory.	Appropriation.			Number of sessions.			Number of institutes.			Attendance.		
	1907-8	1908-9	1909-10	1908-9	1909-10		1907-8	1908-9	1909-10	1907-8	1908-9	1909-10
South Carolina.....	\$2,000.00	\$755.00	\$1,141.68	20	265		40	10	78	13,392	5,848	9,000
South Dakota.....	7,000.00	7,000.00	10,187.22	325	368		86	88	106	43,560	44,357	48,500
Tennessee.....	5,000.00	5,000.00	5,000.00	64	46		84	40	23	18,915	55,300	8,910
Texas.....	382.25	2,116.00	3,000.00	199	240		36	87	130	(1) 626	11,049	3,258
Utah.....	3,485.32	2,825.11	6,442.35	217	240		25	53	31	26,926	18,089	29,573
Vermont.....	5,000.00	1,000.00	1,500.00	12	65		28	5	37	(1) 5,160	600	5,190
Virginia.....	(1)	2,000.00	4,000.00	260	(1)		(1)	130	236	(1) 13,346	25,000	22,000
Washington.....	5,000.00	5,000.00	8,750.00	238	177		78	84	65	15,465	15,465	14,083
West Virginia.....	5,644.41	9,249.29	6,630.00	356	307		112	98	84	16,748	19,424	27,398
Wisconsin.....	20,000.00	20,000.00	20,000.00	705	660		141	140	133	89,244	93,090	100,519
Wyoming.....	1,000.00	1,633.18	1,737.54	71	98		11	20	17	3,359	4,403	4,108
Total.....	325,593.54	345,666.49	492,374.25	15,535	16,586		4,643	5,014	5,651	2,098,208	2,240,925	2,395,908

1 No report.

No institutes held.

THE RESULTS OF AGRICULTURAL EXTENSION IN BELGIUM.

Translated and summarized by J. M. STEDMAN, *Assistant Farmers' Institute Specialist, Office of Experiment Stations.*

INTRODUCTION.

Special interest is now felt throughout the United States in agricultural extension. State and national legislators, the managers of the great transportation companies, the officers of boards of trade, residents in towns and cities, as well as educators and educational institutions, particularly the agricultural colleges and experiment stations, and State and national departments of agriculture, all have suddenly come to realize the immediate and paramount importance of the practice of a better agriculture by the great body of farming people in the United States. Just now attention is turned as never before toward the discovery of effective and economic methods for accomplishing this end.

That which has come upon this country with such suddenness was felt by older nations years ago and efforts were then begun to provide for the future food requirements of their growing populations before these populations would have overtaken production and their people be face to face with insufficient means for self-support. In endeavoring to solve the problems that land impoverishment had brought upon them various experiments were tried by different countries with varying degrees of success.

An examination of the present condition of agriculture in European countries, compared with that when attention to better farming first began, shows that there has been great advance and that the limit of production has not yet been reached. The results that have been accomplished in one of the smallest countries of Europe—Belgium—and the methods that were employed in effecting her remarkable advance have been set forth in detail in a recent publication¹ by the minister of agriculture of that country giving the methods employed in each Province, and the rise in price of agricultural lands, and increase in their productive power during the last 25 years.

This report is of special interest just now because extension work has been carried on in Belgium long enough and thoroughly enough

¹ L'Agriculture Belge de 1885 à 1910. Monographies publiées à l'occasion du XXV anniversaire de l'institution du service des agronomes de l'état. Louvain, Imprimerie Fernand Giele, rue de la Station 15, 1910.

to show how it affects agricultural conditions and benefits agricultural people. A translation and an abstract of this report has been made by the assistant farmers' institute specialist of the Office of Experiment Stations, and is herewith presented in the belief that the experiment in Belgium is well worth consideration by all who are interested in the extension movement in the United States.

The area of Belgium is only 11,373 square miles, about equal to that of the States of Vermont and Delaware combined, and with a population in 1900 of 6,693,548, equal to that of the six New England States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. Of the entire area, there was in 1895 under cultivation 4,288,349 acres; in woodland, 1,288,092 acres; uncultivated, 470,396 acres; the remainder was in cities, roads, marsh land, rivers, etc.

About one-fifth of the people are engaged in agriculture. Their holdings are mostly small, varying from about 1 acre to 100 and over. In 1895 the number of holdings of less than $2\frac{1}{2}$ acres each was 544,041; there were 190,833 ranging from $2\frac{1}{2}$ to 12 acres; there were 50,065 from 25 acres to 50 acres; 12,951 holdings from 50 acres to 125; and 3,584 holdings of 125 acres and over. The agriculture of the country was in a much-neglected condition prior to 1885, at which time a method of improvement was adopted that has produced remarkable results. Under this system the average for wheat in Belgium has been raised from 24.54 bushels per acre in 1885 to 38.55 bushels in 1910, an increase of 14.01 bushels; the average for rye was increased from 23.86 bushels in 1885 to 36.69 bushels in 1910, an increase of 12.73 bushels per acre; oats from 49.75 to 81.48 bushels, an increase of 31.69 bushels; barley (winter) from 38.25 to 57.57, an increase of 19.32 bushels. The number of horned cattle increased from 1,382,815 in 1880 to 1,817,687 in 1907; hogs, from 646,375 to 1,379,462.

The price of farm lands in the same period rose from \$105 per acre in the Province of Anvers to \$162; in Brabant, from \$160 to \$225 for sandy land, and for sandy clay from \$280 to \$340 per acre; in West Flanders the increase was from \$243 to \$405; in East Flanders there was a rise of from 40 to 50 per cent; in Limburg, an increase of \$120 to \$150 per acre; in Luxemburg, from \$120 in 1885 to \$162 in 1910 for arable land, and from \$189 to \$202 for prairie land. In this same period the home surroundings of the farmers were also greatly improved, the quality of the live stock was much bettered, and a great industry has arisen in market-garden products and in floriculture. A summary showing the degree of progress of each Province is given in the table appended to this report.

The remarkable improvement in the agriculture of this country is attributable, as has been intimated, to the measures adopted in 1885, whereby the Office of Extension Supervisors was created by the

Crown, and the oversight of agriculture in the various Provinces was placed under the control of these supervisors. Their specific duties and methods of operation are explained in the discussion that follows, and are suggestive of methods that might be put into operation in improving agriculture in the United States.

EXTENSION SUPERVISORS.

The office of extension supervisors was created by royal edict the 26th of September, 1885. The supervisors have for their principal mission the popularization in a practical manner of the knowledge and processes of agricultural science. They put themselves in direct contact with the cultivators and give them gratuitously the counsel desired. They perform the functions of nomadic (peripatetic or itinerant) agricultural lecturers in their territory and organize annual conferences in at least five districts throughout each section, in order to hold a complete course on some one or other branch of the science or the practice of agriculture applicable to the region. The supervisors are further charged with organizing demonstration or experiment fields in order to give practical instruction to the farmers.

The fields of operation of the extension supervisors were distributed according to agricultural regions, the entire country being divided into six such divisions, three of them being covered by two supervisors each and the other three having one supervisor each.

The chief extension supervisors were appointed by royal edict the 26th of September, 1885, and after installation by the minister of agriculture they entered upon their duties on the 15th of October, 1885.

Under the direction of M. Carluvels, inspector general of agriculture, and M. Proost, director general of the rural office, the new service was not long in attaining the highest results.

In 1894, experience having demonstrated that it would be advisable to make the fields of operation of the extension supervisors correspond to the administrative division of the country, a ministerial decree was issued providing that each of the governmental Provinces should be served by an official agriculturist with one or more deputies, the deputy agriculturists to be specially charged with serving, under the direction and responsibility of the provincial agriculturist, a group of agricultural assemblies (civil divisions). The deputy assistant agriculturists fulfill, then, the same functions as the provincial agriculturists. In 1897 the administration decided to place them on an equality with the provincial agriculturists as regards their title and their relation with the central administration and with the public.

The royal edict of the 25th of October, 1897, countersigned by the minister of agriculture, provides that the corps of extension super-

visors comprise 20 agriculturists. The distribution of the fields of operation of the service according to the administrative divisions is preserved.

A royal edict of the 24th of December, 1898, coordinates all of these edicts and modifies the arrangement in effect at that time concerning the services of the agriculturists. This edict fixes the salaries of the supervisors and provides that in order to be nominated to the office one must have the diploma of agricultural engineer. Exception to this rule may be made with those who have conspicuously proven their knowledge of agriculture and successfully passed an examination before a special jury.

There are now 34 extension supervisors in Belgium, besides numerous assistants.

The edict of the 24th of December, 1898, defines the purpose of the supervisors as follows:

(1) To popularize the information and operations of agricultural science, especially by means of oral consultations, conferences, demonstration, or experiment fields, etc. They are to place themselves in direct relation with the cultivators and give them, free of charge, the counsel they desire. They are to fulfill the functions of a technical adviser and agricultural lecturer.

(2) To inform the cultivators of the advantages which they are able to procure through associations, to furnish precise data regarding such organizations and the functions of the different agricultural groups.

(3) To enlighten the central administration regarding the work of the official agricultural societies or auxiliaries and their financial encouragement due to the subsidies which they receive and also regarding the honorary distinctions which are to be granted.

(4) To organize and to direct the agricultural courses for adults, courses in horticulture, arboriculture, vegetable gardening, etc.

The organic edict provides for one or more temporary assistants to each supervisor, their duties being to give the agricultural courses and to organize the demonstrations established at the expense of the State. Besides organizing agricultural associations and giving regular complete courses of instruction on a particular subject, the extension supervisors give numerous isolated conferences and talks on subjects of general interest. In 1886 these agents gave a total of 400 agricultural conferences.

The minister of agriculture issued a decree dated 28th of September, 1885, requiring at Government expense the organization of experiment fields under the direction of the supervisors. These practical tests or experiments and scientific demonstrations must include the composition and fertility of the soil, the adaptation or acclimatization of desirable plants, and the employment of improved

machinery. The experiments likewise include, according to the region, tests of garden vegetables, horticulture, forestry, apiculture, the care of poultry and of milk, the raising, feeding, and fattening of live stock, etc.

The number of experiment fields under the control of the supervisors is considerable. In the beginning they were utilized to test fertilizers and new varieties of plants and were largely demonstrative in character. The use of these experiment fields is to-day largely extended, and for the past 10 years they have been used more for the acquisition of new knowledge than for the popularization of known facts. Since 1903 uniform and systematic experiments have been organized for each region of the country in order to obtain practical information regarding the fertilizers needed and the influence of thorough cultivation. Experiments on the feeding of dairy cows and the fattening of cattle and hogs have likewise been systematically organized since 1901. When occasion has arisen experiments have also been carried on regarding the diseases of plants. Forecasting the weather has also been conducted for several years by this organization.

The supervisors assist and encourage by giving advice and counsel in the organization of agricultural societies, but do not take part in their creation. In their administrative relation the supervisors are called upon to give advice on all questions relating to agriculture in their territory—agricultural statistics, organization and control of agricultural extension instruction, orders of merit, subsidies to agricultural societies, etc.

The following account of the agriculture of Belgium from 1885 to 1910 has been compiled from information furnished by the extension supervisors, and published by the committee of organization, of whom Baron H. della Faille d'Huyse is president, under approval by the Honorable Baron de Morean, minister of agriculture, industries, and public works.

PROVINCE OF ANTWERP.

When the extension supervisors were established, in 1885, the agricultural conditions throughout the Province of Antwerp were very unsatisfactory. Farming people, as a class, were doing well to meet expenses, and were consequently moving to the larger towns and cities in quest of a living which would at least not leave them in debt at the end of the year. The young people, especially, had been for some time migrating to the cities in alarming proportions, but now the farmers themselves were following whenever possible.

The great progress in agricultural practice, realized largely through the efforts of these extension supervisors, has now completely modified this state of things. The farmers of Antwerp possess to-day

the scientific knowledge necessary to a rational understanding of successful agricultural exploitation and are applying to their industry the numerous benefits secured. Agriculture has again become remunerative, and the sons of farmers are remaining on the farms and becoming proprietors themselves. Thus emigration to the cities has become very rare in the last few years.

This improvement in rural conditions has reflected to increase the value of land. In 1895 arable land sold for \$105 per acre, now it is \$162 per acre. Prairie land was \$146, now it is \$243. Heath land was sold with difficulty in 1885 at from \$4 to \$16 per acre, while now this same land, uncultivated, sells at from \$16 to \$56, and it is not rare to see it sold for \$64 per acre.

In 1885 the average production per acre for two districts in Antwerp was: Wheat, 22.27 and 25.23 bushels; rye, 21.47 and 25.44 bushels; oats, 44.53 and 47.5 bushels; potatoes, 193 and 222.6 bushels. To-day these two districts produce, respectively, wheat, 29.68 and 32.5 bushels; rye, 30 and 33.4 bushels; oats, 65.2 and 68.26 bushels; potatoes, 296.9 and 291.5 bushels. In the space of 25 years the money value of the annual products of these four crops has increased \$559,200 for the first district and \$1,850,000 for the second. When all farm products, such as live stock, truck vegetables, fruits, etc., are considered, the increase is even vastly more apparent, since great advances have recently been made along these lines of production.

The extension supervisors have contributed much to the general rise and increased vigor in agricultural production. By their numerous conferences and personal consultations, and also by the demonstration fields organized by them in every community, they have enlisted the cultivators in the path of progress.

At the time of the establishment of extension supervisors in 1885, chemical fertilizers were practically unknown to the cultivators, the only commercial fertilizer being guano from Peru, which was subject to adulteration and but little used. A very few men were experimenting with nitrate of soda, but as this was applied alone and without the use of potash and phosphate, and consequently injured the soil, it was with great difficulty that they were finally convinced of the beneficial results secured by the use of chemical fertilizers when rationally employed. However, the supervisors accomplished a change of attitude in a remarkably short time by their conferences on fertilizing the soil, personal consultations, and numerous demonstrations and experiments in the fields. To-day chemical fertilizers are used in large quantities, but they are mixed by the planters themselves to suit their particular needs.

A great change has taken place in regard to the employment of farm implements. While in 1885 the farmers seldom had other implements than the simplest plows and harrows and churns run by a

dog mill, to-day they have centrifugal cream separators, Danish and Victoria churns, thrashing machines run by horsepower, and more perfect winnowing machines. On a great many farms one now finds the most modern plows, harrows, subsoilers, and the like; potato diggers, cutters and choppers of all kinds, and, in spite of the small fields, mowers and binders are making their appearance, and also hay turners and rakes drawn by horsepower, and on the larger farms seed drills and fertilizer distributors. Occasionally one now sees gasoline motors used to run the various farm machines.

Considerable progress has been made in the improvement of horses found on the farms, both for labor and breeding purposes, and still greater improvement in regard to milk and beef cattle and in the general sanitary conditions about the premises. In all cases the value of stock has increased accordingly.

Wonderful progress, amounting to a complete revolution in the dairy industry, has taken place during the past 25 years. In 1885 practically the only apparatus for dairy work on the farms were the old-fashioned churns. To-day we scarcely find a farm without a centrifugal cream separator, refrigerators, modern churns and other machines for the proper care and handling of milk and for the making of butter and cheese, and the larger farms now have their own ice machines. The cooperative and other creameries are now all modernized and the dairy industry is the most perfect obtainable and has had a great influence in elevating agriculture as a whole.

A great improvement in the construction, arrangement, furnishing, sanitation, and comforts of the houses has also been noted during the past 25 years. The farmers as a class live now in what would have been called luxury then. The same is also true regarding both food and raiment.

Since their organization the extension supervisors have given in the Province of Antwerp 1,975 conferences. In the beginning they dealt with the treatment of manure, the composition and rational use of chemical fertilizers, and the fertilization of prairie land. At this time the cultivators possessed absolutely no knowledge regarding the active elements of fertilizers or their action on the soil or plants and they were openly opposed to their use. They were also loath to attend the conferences, and in the beginning several had to be held in the same locality and on the same subject in order to obtain a small audience. The cultivators were mistrustful, but fortunately this was gradually overcome and their confidence gained when they saw the results obtained by putting the principles enunciated in the conferences into practice in the demonstration fields. Thenceforth the conferences were attended by greatly increasing numbers of interested listeners. After the use of chemical fertilizers became generally adopted, the conferences took up the subjects of

better seed, the manufacture and improvement of butter, the establishment of cooperative dairies, the feeding and raising of stock, the creation of pastures, the improvement of stables, and the establishment of agricultural societies, etc. Of 2,000 written requests for information received by the supervisors, practically all came from large cultivators or proprietors of estates, the small farmer not availing himself of this method. The supervisors were able to reach a great many small farmers and render them assistance by visiting the markets and talking with them regarding their products displayed for sale. In some regions the farmers even now do not invite the supervisors to visit their farms, while in other regions they do so quite generally and write for them to come and look over their premises and make suggestions.

The experiment and demonstration fields in the Province of Antwerp number 750 and have been, together with the conferences, the principal factors for agricultural progress.

In order to prepare the cultivators for a better understanding of the conferences, to create a desire for information and improvement, to hasten the dissemination of scientific agricultural information, the Government organized, under the direction of the supervisors, courses in general agriculture for adults, consisting of from 15 to 30 sessions each. The instruction is given during the winter, usually in the evening, by agricultural engineers or other agriculturists holding the proper certificate of proficiency. The lessons are illustrated as far as possible by lantern slides, simple chemical operations, etc. Since 1889 there have been held in the Province of Antwerp 504 such courses, consisting of a total of 6,587 sessions, with an average attendance of 50.

During the past 10 years there have also been held in the Province of Antwerp 66 courses designed especially for the daughters and wives of cultivators, which comprised 273 sessions, with an average attendance of from 70 to 80; also 185 courses in horticulture, consisting of 1,860 sessions, with 30 to 50 people in attendance at each session; 101 courses in truck gardening, consisting of 969 sessions, with from 20 to 40 in attendance; 15 courses in floriculture, with 110 sessions; 147 courses in apiculture, comprising 601 sessions, with an average of 40 in attendance; 56 courses in aviculture, with 203 sessions; and special course in agriculture for soldiers, consisting of 47 courses of 30 sessions each.

Many different kinds of associations of farmers have been established throughout the Province, such as cooperative dairy associations, associations for the insurance of the lives of horses and cattle, associations for the benefit of sugar-beet producers, associations for mutual relief, associations of credit, and associations for purchasing. The creation of the first associations was difficult, but from the

moment they were well established the farmers saw their advantages and quickly established others.

Pure expositions of agricultural products have now been largely superseded by contests for prizes, not only for live stock and farm crops, but also for hygienic and well-kept stables, and it is hoped soon to extend this to include the entire farm. The extension supervisors assist in the holding of these contests and in the judging by scale of the points (score card). The Government gives certain subsidies to encourage the improvement of stables. Live stock entered for these contests must be confined to registered pedigreed stock. Expositions are also given of illustrative and demonstrative materials to be used in the teaching of agricultural subjects. The extension supervisors also assist in gathering agricultural statistics and in making an agricultural census.

PROVINCE OF BRABANT.

Since 1885 the value of farm land in the Province of Brabant has increased in the sandy regions from \$160 to \$225 per acre, and in the sandy-clay regions from \$280 to \$340 per acre. This increase in the value of farm land is justified because the farmers now know how to increase production greatly over former years by the proper use of fertilizer, improved seed, and more productive varieties, and at the same time to lessen the cost of production by the more general use of more and improved machinery and implements, thus greatly increasing the money-earning power of the land.

Truck gardening has made great strides, especially in the sandy soils in the cantons of Louvain, Aerschot, and Haecht and in the neighborhood of Brussels.

Vast quantities of commercial fertilizer are now used, whereas a few years ago their importance was not dreamed of.

Economic conditions have brought about a change in regard to the use of machinery and implements on the farms. As a result of the exodus of rural people in increasing numbers each year, cultivators were forced to resort more and more to the use of machines and implements to take the place of manual labor. The smaller cultivators, who can not afford to own their own machines, have frequently clubbed together and purchased them for common use, and others have resorted to the credit associations and institutions. Hence to-day one finds on the farms all the modern and improved machines, implements, and tools that can be of service in farm operations, many of which are made in foreign countries.

The number of horses, beef and dairy cattle has increased not only in numbers, but more especially in value, the latter being at least 25 per cent greater than it was 25 years ago. An enormous amount of

commercial concentrated foodstuffs is now used in the feeding of live stock, especially beef and dairy cattle, whereas 25 years ago practically none was utilized. This has enabled the handling of more live stock and at the same time reduced the cost.

The supervisors have been the cause of the creation of a large number of cooperative dairies, all of which are prosperous, and they created in 1899 a dairy school for young men at Betecom, which was afterwards moved to Oplinter and which has exerted a great influence in building up the dairy industry in the Province of Brabant and also in neighboring Provinces.

Aviculture has made the greatest development in the cantons of Aerschot, Haecht, and Wolverthem, where it constitutes the principal industry of the smaller farm products. A school of aviculture has now been established in Londerzell.

Whereas 25 years ago most cultivators had a mortgage on their farms, to-day these have been largely removed or greatly reduced. Their houses likewise have been improved in every possible respect, and their food has undergone a marked change. Wheat bread has now taken the place of the former rye bread, and where in former years meat was eaten rarely oftener than once a week, it now constitutes a daily diet. Rural people also dress better than formerly, but are unfortunately abandoning their characteristic peasant costume and adopting that of the townfolk.

Since 1885 farming has become more and more intensive, and oats, flax, and beets have acquired considerable importance, while in the northern part of the Province of Brabant the cultivation of early potatoes, peas, and asparagus has become very lucrative. In the environs of Brussels the production of "wiltloof" is a great industry. So also are strawberries, and about Hoeylaert the forcing of grapes under glass is a notable occupation.

The courses in general agriculture and in special agricultural subjects, agricultural conferences, the distribution of agricultural literature, the organization of agricultural libraries, and the instruction in agriculture in the primary schools have all played their part in the improvement of agriculture, but the most important means contributing to this fortunate change are the personal, oral consultations and visits to the individual farmers by the extension supervisors and the demonstrations carried on by them in numerous fields throughout the Province.

PROVINCE OF WEST FLANDERS.

As in other Provinces of Belgium, the value of farm land in West Flanders has greatly increased during the past 25 years. In 1885 it was not over \$243 per acre, while in 1910 it was from \$365 to \$405. The production of all farm products has likewise increased from 30

to 50 per cent above what they were 25 years ago. This increase in production arises principally from the improvement of farms, due to more intensive culture, better fertilization, seed selection, and the more general use of improved machinery. The total money value of farm crops in the year 1885 was \$30,130,400, while in 1908 it was \$43,425,000, an increase of \$13,294,400.

Fruit orchards have slightly decreased in area while vegetable gardening has greatly increased, especially in the vicinity of large villages and cities and in the neighborhood of canning factories. By reason of its proximity to England, and the easy and rapid means of communication, vegetable gardening and arboriculture have attained considerable importance in a large part of the Province.

In 1885 practically no chemical fertilizers were used, while to-day great quantities are purchased. In 1907 there was used in this Province 144,219 tons of chemical fertilizer.

The character of live stock on farms has greatly improved, and their number and individual values have also considerably increased. The increase in money value of live stock since 1885 is given at \$12,742,400. The feeding of live stock has also undergone a change during this period, resulting in a more rational system with the use of concentrated commercial food to increase production and lessen its cost. Vast quantities of concentrated commercial feeding stuffs are now purchased especially for dairy and beef cattle, 220,678 tons having been consumed in 1907.

The dairy interests have developed and improved in every respect. More dairy cattle are being kept, they are of a better class than formerly, they are fed more intensively and rationally, are housed under better sanitary condition, and the milk is likewise properly cared for. The manufacture of butter is now done by the use of the latest improved machinery, and under perfectly clean and sanitary conditions. The 131,031 dairy cows in the Province in 1907 averaged 242 pounds of butter per year each. The first cooperative dairy in the Province was established in 1889, while to-day there are 25, and they are being added to each year, sometimes by the conversion of other dairies into cooperative ones.

The raising of poultry has become an important industry in certain sections of the Province. By selection and more rational feeding, a more profitable and a better class of fowls is now general. The number of fowls in the Province has almost doubled during the last quarter of a century.

As a result of the general dissemination of modern, scientific agricultural knowledge, farmers are abandoning their old methods of procedure and adopting rational, scientific methods, with the result that they are making much more money than formerly and are rapidly getting out of debt and accumulating a surplus, while at the same

time they are living better in every respect and more of their children are receiving an education.

Since 1885 the extension supervisors in West Flanders have held 2,406 conferences, mostly upon the proper use of commercial fertilizer, the selection of proper seed and plants, the feeding of live stock and more hygienic stables, and the advantages of various associations for the purpose of mutual help in purchasing and selling, and for the insurance of horses and cattle, and the fostering of special agricultural industries.

As cultivators become more impressed with the benefits to be derived from a technical knowledge of some agricultural subject, they resort more freely to the means of obtaining their information by writing to the supervisors for the definite information desired, and 5,565 such written requests have thus far been complied with.

Considerable influence has been obtained by the supervisors visiting the principal markets and conversing with and advising the farmers, and frequently visiting their farms in order to give more accurate assistance.

The number of experiment and demonstration fields established in the Province of West Flanders since 1885 at the expense of the Government is 800. These fields are distributed in various localities where the people are more anxious to learn and take a greater interest in improving their conditions, and the farm of some prominent and influential cultivator is selected. They have demonstrated to the farmer the importance of the proper use of manure and commercial fertilizers, of improved implements, better tillage, more intensive culture, the advantages of seed selection, the use of improved or better varieties of field and garden plants, fruit trees, and small fruits, and the rational and intensive feeding of cattle.

Since 1888 there have been given in this Province 816 courses for adult cultivators, comprising 9,012 sessions, with a total attendance of 272,500 persons. These courses have resulted in a marked improvement in the general understanding of scientific agriculture, but, of course, do not take the place of the professional agricultural schools, which alone are able to give an extended course. Courses designed especially for farmers' wives have been given since 1901 and with excellent results, 129 having thus far been held, consisting of 645 sessions with 45,000 in attendance.

There have also been given 316 courses in horticulture, consisting of 2,414 sessions, with a total attendance of 96,560; 136 courses in vegetable gardening, consisting of 950 sessions, with 33,250 in attendance; 75 courses in aviculture, consisting of 375 sessions, at which 14,500 were present; 252 courses in apiculture, comprising 1,008 sessions, were held since 1890, with 22,176 in attendance; and more recently 19 courses in floriculture, composed of 116 sessions, with 4,640 in attendance.

As the great mass of rural children attend school during the primary grades only, and as some early insight into the great field of agricultural knowledge would tend to create a better interest in after life in the courses and conferences for adult farmers, an effort is being made to introduce some of the phases of this work into the primary schools; not by the use of textbooks, but wholly by object lessons, and thus develop the power of observation.

As the mass of the farmers' daughters obtain no instruction whatever in school regarding domestic science and economy, there has recently been established movable schools for giving instruction in these important matters.

Agricultural associations are of recent date, but they have been created through the activities of the supervisors in increasing numbers until to-day there are in the Province of West Flanders the following:

- 196 unions of special agricultural activities.
- 11 societies of apiculture.
- 42 societies of general agriculture.
- 34 societies for credit (Raiffeisen).
- 63 syndicates for raising cattle.
- 120 syndicates for raising horses.
- 45 syndicates for raising rabbits.
- 24 associations for the insurance of the lives of cattle.
- 26 associations for the insurance of the lives of horses.
- 130 associations for the insurance of the lives of goats.
- 14 associations for the insurance of the lives of hogs.
- 9 farmers' clubs.
- A total of 714 associations.

PROVINCE OF EAST FLANDERS.

Twenty-five years ago the farmers of the Province of East Flanders were in a deplorable and critical condition, but now, thanks to the work of the extension supervisors more than to any other one thing, they are a happy and prosperous body. Their arable farm land has increased in value 40 to 50 per cent, and they are now producing at a less cost more crops to the hectare. The following table will serve to illustrate the changed condition as regards the average production per acre:

Increase in crop production in East Flanders, 1880-1907.

	Wheat.	Rye.	Oats.	Winter barley.	Sugar beets.	Forage beets.	Potatoes.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Bushels.</i>
1880.....	27.40	29.29	61.10	41.04	26,181	36,987	219.25
1907.....	38.86	42.00	85.80	53.00	28,413	55,639	286.55
Increase.....	11.46	12.71	24.70	11.96	2,232	18,652	67.30

With some rare exceptions, all farm products have increased in the same proportion. These results have been attained by reason of the diffusion of the principles of agriculture among the mass of farmers.

Truck gardening has made greater progress in this Province than other forms of agricultural production. Orchard fruits have also undergone an increase and a change to better varieties.

The use of commercial fertilizers was most difficult to establish, especially among the small farmers, who constitute the bulk of the rural people. They were skeptical and mistrustful and did not approve of the innovation in their practice; but when they repeatedly saw the results due to their use in the experiment and demonstration fields, they gradually availed themselves of its advantage. The use of improved machines and implements has also been generally adopted. With the exception of sheep, which have diminished on account of more intensive methods of farming, the live stock of the Province has increased, especially the cows and hogs, not only in quantity, but also in quality and in price. With this increase and improvement in live stock, the use of concentrated commercial foods has also greatly increased.

In 1883 the first steam dairy or creamery in the Province was founded, and in 1890 the first farmers' cooperative creamery was established. Since then cooperative dairies have rapidly increased in number until now there are 82, besides numerous private creameries. In certain regions it is still difficult to get farmers to enter into cooperative associations, and butter is still made individually at the farms, but always by the use of improved utensils.

The poultry industry has made notable progress in every respect and is highly remunerative.

With the vast improvement in all farm operations and products has likewise come a great change for the better in the construction of farm buildings for stock as regards durability, convenience, and sanitary conditions. When new houses are to be built they are now constituted of better material, on a more commodious scale than formerly, and are more conveniently arranged and hygienic. The financial condition of the cultivator is also generally improved, as is shown by the increased savings deposits in their banks. Likewise his daily food has undergone an improvement similar to that observed in the other Provinces. Rural people are dressing better than formerly, and especially in certain regions are beginning to crave luxuries. Their children are being more generally and better educated, and the adults themselves are now anxious to learn through conferences, lecture courses, experiment and demonstration fields, and the like.

The extension supervisors have held since 1885 about 2,500 conferences, not including approximately 1,800 short lessons, and 9,500 written consultations have been furnished. Oral consultations are

eagerly sought by the farmers on market days, the supervisor having previously announced in the agricultural press his intention of being at a certain market on a given day. In the Province of East Flanders the farmers are thus able to consult with the supervisors each week in the villages near their homes, besides having the privilege of attending near-by conferences, of which each supervisor holds nine each month. About 1,500 experiment and demonstration fields have been organized, with the most beneficial results. There have also been organized 600 courses in agriculture for adults, consisting of about 7,000 sessions. Like the conferences these courses in the beginning were attended by a large number of people out of pure curiosity. When this was satisfied, the attendance decreased until an interested audience was secured, but of late the interest has increased to such an extent that the attendance is too large to handle with the best results. About a dozen courses designed especially for women on the farm have been given. Courses are also held in horticulture, in market gardening, in floriculture, and occasionally in apiculture, aviculture, and farriery.

Extension supervisors have had charge of some courses in agriculture in some of the schools in the Province, and since the ministerial decree of the 19th of April, 1899, making a special financial grant to those schools attaining a certain standard in agricultural instruction, the board of inspectors has included a supervisor who also acts in an advisory capacity.

About two-thirds of the numerous agricultural societies, associations, clubs, and syndicates of all kinds have been organized as a result of the efforts of the supervisors, and these organizations are prosperous and doing a great work. Syndicates for the improvement of live stock, of which there are 150 in the Province of East Flanders, are subsidized by the Government. Competitive exhibits of various agricultural products, live stock, machines, etc., have been held, and awards have also been granted for improvements in farms as a whole, and in pastures, orchards, and stables as a stimulus to further effort.

PROVINCE OF HAINAUT.

During the past 25 years the products of the farm have increased as a rule about 30 per cent. This increase is partly due to the division of some of the larger farms into a number of small ones, and to more intensive cultivation.

Commercial fertilizers were first used in this Province some 45 years ago by the sugar-beet manufacturers, but the general farmers did not make use of them, largely on account of ignorance of their value, their liability to adulteration, and the hostility of certain land proprietors who introduced into their leases clauses prohibiting their

employment. The establishment of agricultural laboratories in 1872, the organization of professional agricultural conferences, and the agricultural press gradually paved the way for the general utilization of commercial fertilizers, which was vigorously expounded by the extension supervisors as soon as they were established, and resulted in a short time in their universal application.

The most noteworthy and striking change that has occurred in the agricultural industry of the Province during the last quarter of a century has been along the line of the more general use of machinery and implements of all conceivable kinds that take the place of manual labor. The improvement in these has been considerable, but their increased use, which is now practically universal, is in marked contrast to their general absence 25 years ago.

Horses and cattle have of late years greatly increased in quantity, quality, and price. The raising of horses forms a prominent export industry, and their improvement within the past few years has fully offset the increased market value now obtainable. The greatest improvement in the number and quality of cattle has been in the dairy breeds, but even here the uniformity of the stock as a whole throughout the Province is not as pronounced as in the case of horses. The sheep industry has diminished for the same reason that it has done so in other Provinces, while hogs have slightly increased, and poultry considerably so.

The increase in the price of labor, coincident with the import duty on chicory imposed by France, which is the principal market for this product, has lessened the market value and caused a considerable decline in this important industry.

Not enough capital is being invested to insure the best and most intensive cultivation, although matters have improved during the past quarter of a century.

While the farmers are now living better in every respect than formerly, nevertheless there is much room for improvement, and especially in regard to the care and education of the children, who should be kept in school until older and not taken out and made to work on the farm at such an immature age. Rarely, indeed, does one hear of a farmer's son finishing his studies in a technical agricultural school. Of the 40,000 farmers in the Province of Hainaut, only 8,000, or 20 per cent, take an agricultural journal. Hence, in order to interest the masses in obtaining an understanding of modern agricultural practice, it is necessary to hold conferences and courses, to advertise these well, and to send personal invitations by mail; but even then one finds the neglectful and uneducated or indifferent farmer rarely attends, although he is the very one it is desired to reach. It is absolutely necessary to choose the proper day for the

meeting, as outside attractions, such as ball games, and especially cock fights, absolutely prevent the acquisition of an audience.

About 4,000 courses and conferences for adults have been held during the past 25 years in this Province, and 15,000 personal letters of instruction have been written by the supervisors. The personal visits and consultations which the supervisors make to farmers and their fields or buildings are usually the result of invitations which follow previous conversations or correspondence with the cultivators, and they are for (1) to permit the supervisors to judge of the local conditions of the soil, live stock, material, and crops, in order to give intelligent directions; and (2) to put the supervisors in a position to be better judges of the requirements of agricultural instruction of which they have the direction. Certain farmers among the more intelligent class do not hesitate to invite the supervisors to their farms, but it often happens that the supervisors ought to make the proposal themselves, especially when it is wise to make a verification or authentication.

About 320 demonstration and experiment fields have been established in the Province during the past 25 years.

PROVINCE OF LIEGE.

While the number of horses in the Province of Liege has decreased 4,408 head during the past 25 years, the number of cows has increased 50,782, and hogs 75,480 head. This great increase in the number of cows and hogs and the decrease in number of horses was occasioned by the depreciation in the value of cereals, which in certain years amounted to 50 per cent of what it was in 1885, thus resulting in the conversion of cereal lands into pasture. But while the price of cereals has decreased, the amount raised on a given area has greatly increased, as has likewise potatoes. Sugar beets have decreased in the number of pounds produced per acre, but they have been greatly improved in the percentage of sugar they produce, it having been increased from 12 per cent to 15½ and 16½ per cent.

The census of 1880 showed that 6,820 acres were devoted to fruit, while to-day 16,638 are in orchards, and the value of this land has greatly increased.

The great progress in agriculture realized during the past 25 years is seen, not only by an increase in production per hectare and by an increase in the number of cows and hogs, but also by the more general use of improved machines, which have immensely reduced the cost of production and rendered manual labor less necessary and laborious.

Twenty demonstration and experiment fields are established each year in the Province, and about 6,000 conferences have been held during the past 25 years. Written replies for information have

increased as the supervisors increase the number of conferences and courses and become better known throughout the Province, the markets having furnished a fertile field for thus getting into direct touch with the small cultivators. Courses in agronomy consisting of from 8 to 10 sessions are organized each year in about 25 communities, and relate to the soil, fertilizer, seed selection, feeding, and improvement of stock and sanitation. They are taken by farmers from 20 to 35 years of age. More complete courses are given at Liers, Aywaille, and Liege. Other courses are given in horticulture and truck gardening, and special courses for farmers' wives have been held dealing with such questions as the feeding of the family, the care of children, and other subjects of special interest to the farmer's home.

Movable schools have been held lasting four months dealing with domestic economy and the manufacture of cheese. Numerous societies founded in the Province also flourish, such as societies for the insurance of the lives of stock, of agricultural credit, of cooperative dairies, cooperative associations for the purchase of farm machinery, etc.

PROVINCE OF LIMBURG.

As in the other Provinces, the value of all agricultural lands has greatly increased since 1885, and is now worth from \$120 to \$150 per acre more than it was then. Likewise the total production of wheat, rye, oats, and potatoes has greatly increased during the same period. In round numbers the money value of this increase is \$1,800,000.

While the total production of sugar beets has fallen off slightly during this period, the kind of beets formerly grown, yielding only 10 per cent sugar, are now grown only for forage, while the modern sugar beets yield 16 per cent sugar.

Likewise great improvement has been realized in truck-garden vegetables and in fruit, better varieties now having supplanted the former, and the use of commercial fertilizer is now general and highly profitable, thanks to the work of the extension supervisors and agricultural engineers. In the Province of Limbourg the use of commercial fertilizer is a repetition of the same story that has been told regarding the other Provinces.

Horses, cows, and hogs have greatly increased in number during the past 12 years, and horses and hogs have been much improved in quality during the same time.

Dairying has also improved in the past 4 years, as is shown by the fact that in 1891 there were only 2 cooperative dairies in the Province, while in 1892 there were 42, and in 1907 a total of 155.

The savings-bank deposits by farmers have nearly trebled during the past 12 years.

From 1890 to 1910 the extension supervisors have held 1,214 conferences and given 2,248 written consultations, those of a general interest being also published in the provincial agricultural journal. Personal visits to individual farmers amount to four or five per month for each supervisor, and each one likewise holds 100 days' personal conferences at the markets each year, which method appears to be the most popular and preferable way of personally reaching the average farmer.

Since 1890 there have been organized 408 demonstration and experiment fields, not counting numerous smaller experiments not of an official character yet organized according to the advice of the supervisors. The demonstration and experiment fields are regarded as the best professors of agriculture. They teach not only the farmers, but also teach the supervisors, and it is here that the extension supervisors keep themselves in direct contact with practical work, make their own observations, and draw their own conclusions from actual experience.

The extension supervisors have held 358 courses for adults since 1890, consisting of 4,564 sessions, with an average attendance of 56. Likewise, 9 courses, consisting of 75 sessions, have been held for farmers' wives, the average attendance being 65. Courses in orchard fruits have been given in 92 places, comprising a total of 1,134 sessions, with an average attendance of 40. The course in vegetable gardening organized in 1895 have numbered 44, comprising 404 sessions, with 37 as an average attendance. Other courses for adults include 110 on apiculture, composed of 509 sessions; 5 courses in floriculture; 40 courses in aviculture, consisting of 153 sessions; courses on the conformation of the horse and cow and the care of live stock.

PROVINCE OF LUXEMBURG.

Twenty-five years ago the agricultural land throughout this Province was, as a whole, in a most unproductive condition, scarcely producing enough to pay expenses, and in many places not producing enough to pay for the labor of clearing it, and hence vast areas remained uncultivated as waste land and not even as pasture. The mass of farming people were, likewise, in a deplorable condition and barely able to exist. To-day this whole condition of things is so changed and improved as to amount to a complete revolution. This changed condition has all been brought about in the last 25 years by the farmers themselves as a result of having taken advantage of the instructions and followed the scientific principles of agricultural practice promulgated by the extension supervisors, especially in regard to the use of commercial fertilizer, seed selection, improved varieties of plants and live stock, more rational feeding, and improved machinery. The vast area of former uncultivated waste

lands is now cultivated or converted into pastures at a profit, and is producing excellent crops, and the other lands are producing more and better crops accordingly.

During the past 25 years the extension supervisors have held 3,250 conferences and written 3,500 letters in reply to requests for personal assistance, besides the numerous personal oral consultations given the farmers at their homes, but more especially at the markets and fairs. They have also organized throughout the farming region about 1,000 demonstration and experiment fields, which have had a wonderful influence by proving to the farmer the benefits to be derived from following the improved methods advocated in the conferences. These demonstration fields are regarded as the most important single factor in the rapid improvement of agriculture throughout the Province, because the farmers are slow to put into practice the information given them by the supervisors until its practicability has been demonstrated to them and the beneficial results seen to be actually realized. Courses for adult farmers date from 1888. Since then 675 have been held, consisting of 4,000 sessions attended by a total of 200,000 people. Courses on domestic economy and hygiene for farmers' wives have also been given, the 115 courses consisting of 450 sessions and enrolling 27,000 women and girls. One hundred and sixty-six courses in orchard fruits, comprising 1,660 sessions, were given from 1905 to 1910 to 58,100 persons, and during the same number of years there were also held 163 courses in vegetable gardening, composed of 1,466 sessions with 70,000 persons enrolled. Besides the above, there were held 462 miscellaneous courses, composed of 1,385 sessions, treating of the most important needs of the different localities.

Since 1896 agriculture has been taught in the public schools, and the supervisors have therefore visited 750 such schools in company with the district inspectors.

In 1902 the schools of dairying (milk and cheese) were converted into movable schools of economic agriculture, and since then 24 sessions lasting from 3 to 4 months have been held.

Numerous farmers' societies and associations have been organized embracing all the different agricultural activities.

PROVINCE OF NAMUR.

As in the other Provinces of Belgium, agriculture has made great progress during the past 25 years, and is now highly remunerative and the farming people prosperous, well fed, clothed, and sheltered. The changes that have occurred and the reasons for them are the same as those referred to in other Provinces. While the production per hectare of field crops has greatly increased and at the same time their cost of production has greatly lessened, it is a noteworthy fact that pasturage has increased in a larger proportion, so that while

more grain is produced than formerly there is really less land devoted to its cultivation, the difference having been converted into pasture land. This changed condition is due to a decrease in the value of grain and the constant increase in the cost of farm labor, together with an increased demand and remuneration from cattle and their products—meat, milk, butter, and cheese. Hence agriculture in this Province is rapidly changing from the production of grain to the production of cattle, and it is likely soon to become a live-stock and dairy country. Even now this is the principal agricultural industry in the greater part of the Province. A stationary market for live stock and their products and an increasing market for grain may, however, equalize the two industries in a short time.

The extension supervisors have held 1,600 conferences since 1885 and have written 3,000 personal letters of advice, besides having given numerous personal consultations, these latter being regarded of special importance, since the farmers read very little and write less, but talk freely when the supervisor is with them at their individual farms.

But, great as the results derived from personal consultation are, the experiment and demonstration fields are regarded as paramount, since they have paved the way for the influence the supervisors now have over the farmers in personal, written, or public conferences, courses, and other meetings. Until the establishment of demonstration fields farmers were defiant to all ideas of progress. But the practical demonstrations established on the soils of their own community have changed their attitude and proven to them the value of applying scientific agricultural knowledge in their occupation. The supervisors have thus far established 400 such fields at the expense of the Government, besides an equal number at private expense. Enormous progress is attributed to the 580 courses for adult farmers. These comprised 7,200 sessions and reached 22,500 cultivators. There have also been held 75 courses of 600 sessions for farmers' wives; 320 courses in orchard fruit, consisting of 2,400 sessions and having an enrollment of 16,000 people; 181 courses in vegetable gardening, comprising 1,400 sessions with 8,500 listeners, besides numerous other less extensive courses.

The supervisors aid the primary schools in their agricultural work by suggestions and personal visits, but the movable schools of agriculture are considered as accomplishing the greatest good and are held in the highest esteem by the farmers themselves. There have been established since 1891 65 such schools. and their results are very marked.

The Province of Namur is also supplied with numerous associations, syndicates, societies, and clubs, covering all forms of agricultural activities, including cooperative purchasing, buying, and credit associations.

The extension supervisors are called into consultation to assist in every conceivable agricultural activity and organization and take part in the congresses, both national and international. They also assist in the gathering of all kinds of agricultural statistics, compile monographs, make detailed reports to the Government, and, in short, keep in touch with the entire field of agriculture in the Province, with a view to help the farmers on the one hand and to keep the Government posted in regard to agricultural matters on the other.

Increase in value of farm lands in Belgium, 1880-1910.

Provinces.	Value of farm lands per acre.				
	Kind.	1880	1885	1910	Increase.
Antwerp.....	Arable.....		\$105	\$162	\$57
Do.....	Prairie.....		146	243	97
Do.....	Heath.....		4-16	16-64	12-48
Brabant.....	Sandy.....		160	225	65
Do.....	Sandy clay.....		280	340	60
West Flanders.....	Best.....		243	405	162
East Flanders.....	Arable.....				(¹)
Limburg.....	Agricultural.....				120-150
Luxemburg.....	Arable.....	\$120		162	42
Do.....	Prairie.....	189		202	13

¹ 40 to 50 per cent.

Increase in agricultural production in Belgium, 1880-1910.

Province and crop.	Average production per acre.					Demonstration and experimental fields.	Number of extension supervisors.	Increased value of farm crops.
	1880	1885	1907	1910	Increase.			
Antwerp:								
Wheat.....bushels.....	23.75		31.09		7.34	750	2	\$2,409,200
Rye.....do.....	23.45		31.7		8.25			
Oats.....do.....	46.01		66.73		20.72			
Potatoes.....do.....	207.8		294.2		86.4			
Brabant:								
Wheat.....do.....	25.33		40.06		14.73	(?)	4	4,200,000
Rye.....do.....	20.68		40.12		19.44			
Oats.....do.....	53.44		89.06		36.62			
Barley (winter), bushels.....	31.18		60.64		29.46			
West Flanders:								
Wheat.....bushels.....	29.24	41.96			12.72	800	5	13,294,400
Rye.....do.....	31.11	43.08			11.97			
Barley (winter), bushels.....	41.36	57.66			16.30			
Oats.....bushels.....	60.41	103.86			43.45			
Beans.....do.....	28.56	39.9			11.34			
Potatoes.....do.....	242.39	327.91			85.52			
Turnips.....pounds.....	19,408	25,754			6,346			
Tobacco.....do.....	2,182	2,304			222			
Chicory.....do.....	23,225	30,881			7,656			
Sugar beets.....do.....	30,729	32,866			2,137			
Forage beets.....do.....	48,508	54,488			5,980			
East Flanders:								
Wheat.....bushels.....	27.4		38.86		11.46	1,500	4	
Rye.....do.....	29.29		42.00		12.71			
Oats.....do.....	61.1		85.8		24.7			
Barley (winter), bushels.....	41.04		53.00		11.96			
Potatoes.....bushels.....	219.25		286.55		67.30			
Sugar beets.....pounds.....	26,181		28,413		2,232			
Forage beets.....do.....	36,987		55,639		18,652			
Hainaut.....					30% average.	320	4	

Increase in agricultural production in Belgium, 1880-1910—Continued.

Province and crop.	Average production per acre.					Demonstration and experimental fields.	Number of extension supervisors.	Increased value of farm crops.
	1880	1885	1907	1910	Increase.			
Liege:								
Wheat.....bushels..	20.08		39.00		18.92	500	3	
Rye.....do.....	21.21		36.1		14.89			
Oats.....do.....	36.53		82.9		46.37			
Potatoes.....do.....	166.66		203.68		37.02			
Forage beets, pounds.....	30,409		40,662		10,253			
Sugar beets.pounds..	29,494		23,976		¹ - 5,518			
Limbürg:								
Wheat.....bushels..	20.04		36.33		16.29	408	2	
Rye.....do.....	19.76		30.69		10.93			
Oats.....do.....	44.00		71.5		27.05			
Potatoes.....do.....	186.67		216.6		29.93			
Sugar beets.pounds..	28,502		24,992		² - 3,510			
Luxemburg.....						1,000	6	
	1886 to 1895.							
Namur:								
Wheat.....bushels..	25.99		42.55		16.56	400	4	
Rye.....do.....	21.55		33.2		11.65			
Oats.....do.....	47.06		70.2		23.14			
Barley (winter), bushels.....	39.43		59.00		19.57			
Forage beets, pounds.....	33,577		45,900		12,323			

¹ This reduction is balanced by the increase from 12 per cent to 16½ per cent in sugar content.

² This reduction is balanced by the increase from 10 per cent to 16 per cent in sugar content.

During the past quarter of a century the average production per acre for the following cereals has increased, for the whole of Belgium, as follows:

Crop.	1880-1885	1907-1910	Increase.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Wheat.....	24.54	38.55	14.01
Rye.....	23.86	36.69	12.73
Oats.....	49.79	81.48	31.69
Barley (winter).....	38.25	57.57	19.32

In West Flanders practically no commercial fertilizers and no concentrated commercial foodstuffs were used in 1885, while in 1907 there were used 144,219 tons of commercial fertilizers and 220,678 tons of commercial foodstuffs. During the same period the value of live stock in West Flanders increased \$12,742,400.

ORIGIN AND DEVELOPMENT OF THE NUTRITION INVESTIGATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

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INTRODUCTION.

In recent years the experimental study of various problems connected with food and nutrition of man and domestic animals has been actively followed in the United States. Some of the work has been of a very practical nature and some has been highly technical. Though usually not considered together, the studies of the food of man and of animals have much in common, for, of course, the physiological laws which underlie the nutrition of the animal body are essentially the same for all warm-blooded animals. Then, too, many experimental methods are common to both classes of investigation, at least as regards the principles on which they are based, though it is needless to say that the details and the manner of using the methods are varied. A considerable part of this inquiry into problems concerned with the nutritive value of agricultural products and the laws of nutrition has been carried on in connection with the work of the agricultural experiment stations. In the earlier years of the experiment-station movement in this country investigations which had to do with food in a broad sense were quite largely confined to work with domestic animals. However, early in their history many of the experiment stations studied the nutritive value of grains and other foods used by man as well as various problems connected with the storage, handling, and transportation of food products and related questions, and after a time a number of them included studies of the food of man in their regular work.

EARLY NUTRITION WORK IN THE UNITED STATES.

There had been, indeed, a considerable amount of study of the food of man—and of domestic animals also—before the experiment stations were established. An interesting investigation on the subject of human nutrition, namely, a study of the digestibility of some common food materials, was prosecuted by J. R. Young, in Philadelphia, as early as 1803, and perhaps almost continuously since that

time valuable information on food and nutrition has been accumulated by physicians, by State boards of health, and by specialists in physiology, hygiene, and dietetics. The United States Government, through its various branches, has contributed much of value to the science of nutrition. The War Department and the Navy Department, in their efforts to secure the most satisfactory diet for the soldiers and sailors, have collected a great deal of information and conducted many investigations which have to do with the subject of dietetics, while the importance of their investigations dealing with the hygiene of the subject can hardly be overestimated. In connection with the United States census a large amount of data regarding foods has been secured, the major portion of which has to do with production and distribution, though many analyses have been reported in census publications, as well as special studies of foods, food industries, and related topics. Of very noteworthy importance are the studies of analytical methods, of the chemical composition of foods, and of food adulteration conducted in the Bureau of Chemistry of the Department of Agriculture, the studies carried on in connection with the work of the Dairy Division, the Division of Biological Chemistry, and the Meat-Inspection Service of the Bureau of Animal Industry, as well as other bureaus of that department. Though important contributions to the subject of nutrition were made in all this work, yet it was not undertaken for the specific purpose of extending this branch of research.

ORIGIN OF THE NUTRITION WORK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

A complete historical review of investigations on food and nutrition of man in the United States would necessarily include an account of the above inquiries and others not referred to here. The purpose of the present article, however, is to give a brief résumé of the systematic inquiry into the food and nutrition of man carried on under the auspices of the Office of Experiment Stations of the Department of Agriculture, and to indicate the progress and results of that enterprise.

This inquiry had its inception in a study of the chemical composition of food fishes and invertebrates undertaken by Prof. W. O. Atwater in 1877, and continued until 1882, in the chemical laboratory of Wesleyan University, Middletown, Conn., at the instance of Prof. S. F. Baird, Secretary of the Smithsonian Institution and United States Commissioner of Fish and Fisheries. In connection with this work similar investigations of other animal and some vegetable products were undertaken a little later—1884—on behalf of the United States National Museum. About the same time—1886—the first extended inquiry into the statistics of food consumption in

the United States was undertaken by Hon. Carroll D. Wright as chief of the Massachusetts Bureau of Statistics of Labor, and the chemical results were computed and reported by Prof. Atwater. In 1890 the Connecticut (Storrs) Experiment Station, under the direction of Prof. Atwater, in cooperation with Hon. Carroll D. Wright as United States Commissioner of Labor, began a series of dietary studies, which continued for several years. Except for the inquiries under the auspices of the Massachusetts Labor Bureau, the United States Department of Labor, and the Connecticut (Storrs) Experiment Station, the larger share of the expenses of this work was borne by private individuals. The results of these inquiries gradually attracted attention. The bearing of such research upon household, agricultural, and national economics became evident, and as early as 1890 steps were taken to secure an appropriation from Congress to enlarge its scope and usefulness, but nothing definite was accomplished there until 1894. In that year the experiment stations were authorized by Congress to cooperate with the Secretary of Agriculture in studying the food and nutrition of man and were called upon to report to him the results of such investigations as they might carry out. At the same time Congress provided a special appropriation to enable the Secretary of Agriculture to prosecute inquiries in this direction. The sums provided by Congress for nutrition investigations for the Department of Agriculture have ranged from \$10,000 to \$20,000 per annum, the larger sum having been appropriated for the cooperative work which was carried on in a number of different States, as well as for that carried on by the Department of Agriculture in its own laboratories.

As originally planned, cooperation with agricultural colleges and other educational institutions, experiment stations, public institutions, and philanthropic associations in different localities was a distinguishing characteristic of the enterprise. This plan awakened interest in many different localities, and as the contributing institutions in many cases supplied a proportion of the funds required for the work, as well as the time of investigators, the use of laboratories, etc., the scope of the work was greatly extended. Following this plan, cooperative investigations in nutrition were carried on by the Office of Experiment Stations in 22 States and Territories.

The following brief summary, arranged alphabetically by States, shows the localities in which the investigations have been prosecuted and the names of the cooperating institutions:

Alabama.—Tuskegee Normal and Industrial Institute.

California.—University of California and California Agricultural Experiment Station.

Connecticut.—Wesleyan University, Storrs Experiment Station, and Connecticut Bible Normal College.

District of Columbia.—Carnegie Institution of Washington.

Georgia.—University of Georgia.

Hawaii.—Hawaii Agricultural Experiment Station.

Illinois.—Hull House, Chicago; Lewis Institute, Chicago; University of Illinois, and University of Chicago.

Indiana.—Purdue University.

Maine.—University of Maine and Maine Agricultural Experiment Station.

Maryland.—Baltimore Board of Charities and several public institutions in Baltimore.

Massachusetts.—Massachusetts Institute of Technology, Boston; School of Housekeeping, Boston; Wellesley College, Wellesley; Harvard University, Cambridge; and Bible Normal College, Springfield.

Minnesota.—University of Minnesota and Minnesota Agricultural Experiment Station.

Missouri.—University of Missouri.

New Jersey.—New Jersey Agricultural Experiment Station.

New Mexico.—New Mexico College of Agriculture and Mechanic Arts and New Mexico Agricultural Experiment Station.

New York.—Cornell University, Ithaca; Association for the Improvement of the Condition of the Poor, New York; New York Christian Alliance, New York; and Columbia University, New York.

North Dakota.—North Dakota Agricultural College.

Ohio.—Lake Erie College.

Pennsylvania.—Philanthropic institutions, Philadelphia; Drexel Institute, Philadelphia; and Pennsylvania College for Women, Pittsburgh.

Tennessee.—University of Tennessee.

Vermont.—Vermont Agricultural Experiment Station.

Virginia.—Hampton Normal and Agricultural Institute and University of Virginia, Charlottesville.

In addition to the valuable work accomplished, the cooperative work served another important purpose in that it had a great deal to do with awakening an interest in nutrition and in the establishment on a permanent basis of nutrition investigations in agricultural and other colleges and universities, experiment stations, and institutions of different types. After a time circumstances made it necessary to omit the cooperative feature and to center the Department of Agriculture investigations in Washington.

In its earlier years the nutrition enterprise was greatly furthered by the financial aid and other assistance rendered by the cooperating institutions, by grants made for cooperative work by several of the State legislatures, and by the aid of public-spirited individuals.

ORGANIZATION OF THE NUTRITION INQUIRY.

When the nutrition investigations of the Department of Agriculture were authorized their general supervision was assigned by the Secretary of Agriculture to the Office of Experiment Stations, the immediate direction of the enterprise being intrusted to Prof. W. O. Atwater, who was designated "Chief of Nutrition Investigations."

For many years Prof. Atwater, in connection with his work as professor of chemistry at Wesleyan University, devoted much of his time to investigations relating to the nutrition of man, introducing into the United States the German methods of studying nutrition problems. The first nutrition investigations undertaken in an agricultural experiment station in this country were conducted at the Connecticut (Storrs) Agricultural Experiment Station, of which he was the first director. He was also the first director of the Office of Experiment Stations, and after his services in this capacity had terminated the Department of Agriculture was very fortunate in securing his cooperation as special agent in charge of its nutrition investigations. The very great development of this enterprise, as evidenced by the number and extent of the investigations carried on; the public interest which was aroused; the demand for information from private individuals, physicians, and teachers; and the practical application of the results already obtained in numerous instances where rational and economical feeding was a necessity, are indications that he established the investigations on a sound and rational basis.

Prof. Atwater's death occurred in 1907 after a long-continued illness. Until ill health prevented he had continued his supervision of the nutrition investigations and was responsible for the plans and general direction of the work. A large amount of experimental work was also carried on under Prof. Atwater's immediate supervision in his laboratory in the chemical department of Wesleyan University, the Connecticut (Storrs) Experiment Station being a generous contributor to the enterprise. As time progressed and the correspondence and other business arrangements connected with the nutrition investigations developed, it became evident that the enterprise as a whole should be centered in Washington, and at the beginning of the fiscal year 1906-7 supervision of the details of the nutrition investigations and other administrative work was transferred to the Office of Experiment Stations in Washington.

In the later years in which the Department of Agriculture nutrition investigations were conducted in Prof. Atwater's laboratory at Wesleyan University, the Carnegie Institution cooperated in the enterprise to a large extent. When it was finally decided in 1906 to

discontinue the work at Middletown and to transfer it to Washington, the respiration calorimeter and other apparatus which were the property of the department was shipped to Washington for installation in the new department building which was being constructed. Coincident with this change in plans the Carnegie Institution of Washington made very generous grants for the establishment of a permanent nutrition enterprise of its own for which a splendidly equipped laboratory was built in Boston, Mass., and the direction of this institute assigned to Prof. F. G. Benedict, who had been associated with Prof. Atwater in Middletown.

On the completion of the new building of the Department of Agriculture adequate quarters were assigned to its nutrition enterprise and the respiration calorimeter and accessory apparatus were installed. The rebuilding of the apparatus gave an opportunity to introduce many improvements in construction and accessory apparatus, which make for ease and convenience of operation as well as for accuracy.

As at present organized, the nutrition investigation, like all of the work of the Office of Experiment Stations, is under the general supervision of the Director of the office, Dr. A. C. True. The immediate supervision of the enterprise is assigned to the writer as expert in nutrition, and associated with him are R. D. Milner, assistant in nutrition, and a laboratory staff. Provision is also made for the editorial and administrative work which the enterprise involves.

SCOPE OF THE NUTRITION INVESTIGATIONS.

Briefly stated, the purpose of the nutrition investigations is the study of various aspects of the problem of the value as food of agricultural products, both animal and vegetable. Problems which are of especial interest because of their relation to the general work of the department are given preference, and the work involves cooperation with other bureaus of the Department of Agriculture whenever such a plan seems desirable.

The nutrition investigations have now been continued for some 20 years, and during this time have included researches in various branches of the subject, attention having been paid particularly to studies of the kinds and amounts of food consumed by individuals, families, institutions, etc.; experiments on the digestibility of food materials; and researches into the fundamental laws of nutrition, including, particularly, investigations with the bomb calorimeter and the respiration calorimeter. In addition to these, collateral questions of a wide variety have also received much attention. A brief statement of the general lines along which the inquiries have been conducted follows:

In the earlier years of the nutrition investigations many analyses of American food materials were made, as the data regarding the chemical composition of such food materials were comparatively limited. Information along this line has, however, accumulated very rapidly as a result of studies carried on by different investigators, and data are now so abundant that studies of proximate composition of food materials no longer constitute one of the lines of work followed in the cooperative nutrition investigations of the office. Dietary studies—that is, studies of the kinds and amount of food purchased, eaten, and wasted—were early recognized as of great importance, and a large number have been made in private families, schools, colleges, public institutions, and elsewhere, under a variety of conditions and in widely separated regions.

No matter what its composition, food is of no use to the body unless it is digested, and it is natural that experiments should have been undertaken with a variety of food materials to learn how thoroughly they were assimilated by the body and to ascertain the effect of various methods of preparation and combination upon thoroughness of digestion. Furthermore, it is supposable that the occupation in which the subject is engaged, whether active or sedentary, may have an influence upon the work of the digestive tract, and this question has also been studied. Many questions regarding the thoroughness of assimilation may be investigated with the aid of ferments under conditions which approximate those in the body, and a large number of such artificial digestion experiments have been carried on, particularly in studying the ease and rapidity of digestion, a question which is very different from thoroughness of digestion, though the two are often confused in popular discussions of the subject.

Variations in the excretion of nitrogen have long been regarded as indications of changes taking place in the body, and it has been a general custom of physiologists to study the balance of income and outgo of nitrogen. Such studies have formed a part of the nutrition investigations of the department. Much more useful as a means of studying the food requirements of the body and other questions are determinations of the balance of carbon, oxygen, and hydrogen, as well as nitrogen, and determinations of the balance of income and outgo of energy. Such studies necessitate special apparatus, and the respiration calorimeter already referred to has proved itself admirably adapted to this purpose, and it seems fair to say that it is so far the most perfect instrument of its type. The respiration calorimeter is of such a size that a man may remain in comparative comfort in the respiration chamber for a number of hours or days, and the measurements of income and outgo of matter and energy may be made with great accuracy. The determination of energy values of food and

excretory products necessitates some means for measuring the heat of combustion of these materials, and in connection with the nutrition investigations a bomb calorimeter has been perfected which has proved very satisfactory.

Numerous studies have been undertaken of the changes brought about and losses sustained when foods of different sorts are cooked in different ways, the principal food materials included in this work being bread, vegetables, and meat. Canning and preserving fruits and vegetables may be regarded as special applications of cooking processes, and much experimental work has been done along these lines with a view to the elaboration of satisfactory household methods. In general, it may be said that in connection with the different lines of work mentioned it has been necessary to devise and perfect experimental methods, as at the time the investigations were first undertaken the amount of work which had been done in the United States and elsewhere along such lines was not very considerable.

The same period which has witnessed the development of the nutrition enterprise has seen a great interest aroused in the teaching of home economics in schools and colleges, and nutrition is one of the main divisions included in this subject. As the nutrition investigations have supplied a great deal of data necessary to teachers of home economics, and as the office was already closely identified with other educational enterprises, it was almost inevitable that the pedagogics of nutrition should receive attention and become an increasingly important part of the nutrition enterprise.

The preparation of reports of investigations and popular summaries has also constituted an important feature of the work. Some 60 technical bulletins and over 50 Farmers' Bulletins and other popular summaries have been issued. These are described more at length in the following section. Information is also supplied by correspondence, a feature which has grown to large dimensions, and, so far as circumstances permit, by means of lectures and conferences.

An idea of the character of the nutrition work at the present time may be gathered from an account of what was done during the last fiscal year and of the plans formulated for work during the next fiscal year, which will be found on pages 32-37 of this report.

Very recently the respiration calorimeter has been adapted to the study of problems of vegetable physiology, and in cooperation with the Bureau of Chemistry interesting studies are being made of the respiratory exchange and energy output of ripening fruit (bananas).

This kind of work opens up a new and very promising field of usefulness for the apparatus and methods.

TECHNICAL REPORTS, POPULAR BULLETINS, AND OTHER NUTRITION PUBLICATIONS.

The nutrition publications of different sorts which are issued by the department as occasion offers are the principal means by which the information secured through the nutrition investigations and the systematic compilation of data carried on as a part of the work are made available to the public. They have included technical bulletins, series of colored charts, summaries for annual reports of the department and the Office of Experiment Stations, Farmers' Bulletins, separates or reprints, circulars, summaries made for the Experiment Station Record of technical articles on nutrition which have appeared in the United States and other countries, and popular summaries of nutrition investigations carried on at the agricultural experiment stations for the series of Farmers' Bulletins entitled "Experiment Station Work."

It is the policy of the department to distribute all its publications free as long as the supply lasts, and after that to refer applicants to the Superintendent of Documents, Government Printing Office, who is authorized by law to sell all Government publications at a nominal price. The Experiment Station Record, a periodical which is published in two annual volumes of eight numbers each, is distributed to a very carefully selected list, and a considerable list of paid subscribers is maintained by the Superintendent of Documents, Government Printing Office.

Outside the United States there is no general distribution of bulletins free of charge, and both technical and popular bulletins and the Experiment Station Record are sold by the official above mentioned for sums designed merely to cover cost of publication and postage.

The 60 or more technical bulletins issued since the nutrition investigations were organized report data on such subjects as the composition of food materials, studies of experimental methods, results of digestion experiments, special studies of the metabolism of nitrogen and other elements, experiments with the respiration calorimeter, studies of the changes and losses brought about in different food materials by cooking processes, and similar topics.

Two series of colored charts have been issued, each of which was designed to show in graphic form the composition of common food materials and to give some generalizations regarding the functions of food and the theories of nutrition. Like technical bulletins, these colored charts are published in limited editions, but can be purchased of the Superintendent of Documents.

Summaries of nutrition investigations are published both in the annual report of the Secretary of Agriculture, particularly with

reference to the fiscal year covered by the report, and in the annual report of the Director of the Office of Experiment Stations. The annual report of the Office of Experiment Stations regularly contains a summary of information regarding the nutrition investigations and not unfrequently a special article on some nutrition topic. Articles on nutrition topics have frequently appeared in the Year-book published by the Department of Agriculture, and like other such articles are commonly reprinted as separates for special distribution.

The pamphlets entitled "Farmers' Bulletins," issued at frequent intervals by the Department of Agriculture, constitute a useful and very popular series of publications, designed to present in concise yet popular form the results of the department investigations as well as summaries of general data on agricultural topics. Up to the close of the fiscal year ending June 30, 1910, 416 Farmers' Bulletins had been issued. Of this number the nutrition investigations have contributed some 25, which have dealt with such subjects as the Principles of Nutrition and Nutritive Value of Food; Meat—Composition and Cooking; Bread and Bread Making; Eggs and Their Uses as Food; Use of Fruit as Food; Use of Milk as Food; Food Value of Corn and Corn Products; Cereal Breakfast Foods; Canned Fruit, Preserves, and Jellies—Household Methods of Preparation; Preparation of Vegetables for the Table; Economical Use of Meat in the Home; Modern Conveniences for the Farm Home; and Care of Food in the Home. Many of the summaries which have appeared in the series of Farmers' Bulletins entitled "Experiment Station Work" also treat of nutrition topics.

Farmers' Bulletins on nutrition have had a wide distribution, not only among housekeepers in rural regions and in towns, but also among pupils and teachers in schools and colleges, by whom they have been used as general sources of information and to supplement textbooks. Some of the earlier Farmers' Bulletins are no longer available for distribution, having in most cases been replaced by later summaries. Late statistics show that of the 21 which are now available a total of 7,072,000 copies have been distributed. The largest number in the case of any single one of these nutrition bulletins has been 1,200,000. Since these publications are distributed almost entirely on request, the figures quoted give a good idea of their popularity.

Occasionally summaries of work or compilations of data are published in the form of circulars, particularly when it is thought that the material will soon be in need of revision, or perhaps more generally when the article in question is more brief than the average Farmers' Bulletin. Circulars are distributed in practically the same way as Farmers' Bulletins. A circular issued in connection with the

nutrition investigations which has had wide distribution is entitled "The Functions and Uses of Food," and contains some of the general principles of nutrition briefly stated and concise directions for making dietary studies and digestion experiments.

The technical articles abstracted in the Experiment Station Record are grouped under a dozen or so general subdivisions. Abstracts of nutrition literature appear in the section on Food and Human Nutrition, though other sections, such as Agricultural Chemistry, Animal Production, Dairy Farming, and Agricultural Education, contain not infrequently material also of interest in this connection.

That the field covered by the Experiment Station Record is a wide one is shown by the fact that a total of 7,048 abstracts was included in the two volumes for the fiscal year 1909-10. Of these, nutrition abstracts constituted 642. The total number of pages in these two volumes was 1,413. Of these, nutrition matters constituted 123 pages.

RESULTS OF THE NUTRITION WORK, AND CONCLUSION.

Attention has been directed in the foregoing pages to the origin and scope of the nutrition investigations of the Office of Experiment Stations, and some of the problems which have been especially studied in carrying out the work have been pointed out, together with the methods of making available to the people the results obtained.

As regards their origin, all foods, both animal and vegetable, are agricultural products. In the past the farmer was very commonly the distributor of his products and the foods passed directly from the farm to the consumer. At the present day this is much less common, and most of the foodstuffs become articles of commerce before they reach the housewife, and in many cases are manufactured products, as they must pass through the mill, the dairy, the packing house, or other manufacturing institution before they are ready for use.

Briefly stated, the chief object of the nutrition investigations is to secure the better utilization of these varied food products, and it seems fair to say that much has already been accomplished along this line. The housewife in the farm home or in the town has at her disposal a large amount of data regarding the composition, digestibility, and nutritive value of foods and their relative economy as sources of nutrients and energy, which will help her to prepare for her family a diet which is rational and suited to their physical needs. At the same time the investigations have demonstrated the importance of having the daily fare palatable, well cooked, and attractive, and have shown how such requirements may be met without undue cost. The manufacturer and the distributor of food products are

likewise helped by the dissemination of knowledge concerning food materials and their preparation, for such knowledge means a greater development of the important commercial enterprises in which they are interested. The farmer, the cattle raiser, the dairyman, the market gardener, and all who are direct producers of food supplies are benefited, as a knowledge of the important facts regarding the comparative value of different foods can not fail to bring about improved standards of living, and hence a greater demand for the food-stuffs which they alone can supply.

And, finally, quite largely as a result of the nutrition enterprise, the investigator has at his disposal well-defined methods of study which have been carefully tested, while the student and teacher find ready for their use a large amount of material, both popular and technical, which has been accumulated and made accessible by a carefully considered system of publication and distribution.

IRRIGATION UNDER THE CAREY ACT.

By A. P. STOVER.

CONDITIONS LEADING UP TO THE PASSAGE OF THE CAREY ACT.

The history of irrigation development in the arid States is divided into three natural epochs. The first covers the period of early development during which individual and corporate effort accomplished the successful reclamation of the most easily developed bottom lands along the streams. Reclamation during this period was accomplished in practically every instance by the owners of the land, the ownership of the land and of the water being vested in the same individuals. Because of this ideal condition of ownership and control, as well as the fact that only the simplest and cheapest form of ditch construction was employed, practically every enterprise undertaken proved a sound financial success. Great profits accrued from this union of cheap water and cheap land. The successful development which took place during this first epoch was the lure that led naturally to the unsuccessful, not to say disastrous, attempts at development constituting the second epoch.

Promoters and investors realized the great profits being reaped from the small irrigated ranches and farms along the river bottoms, but were wholly unfamiliar with the primal causes of these successes. Naturally they came quickly to the conclusion that if such development was so handsome an investment on so small a scale without the employment of any semblance of business methods, large canal systems, built to supply large areas of vacant Government land, would most certainly be a very profitable investment. What could be more simple than to have settlers take up the fertile lands under some of the existing Government land laws and then secure from the canal company the necessary water for irrigation at a price for a water right and for maintenance that would yield a handsome profit on the company's investment. Settlers were land hungry and would take up the land rapidly. Water was the prime essential to its development and the settlers would be forced to take water from the canal at almost any price the company might name. Such an investment surely was one of promise, because it seemed so fully safeguarded on all sides. As a result, the second epoch, extending from the early

eighties to 1893, the year of financial panic, was an era of corporate canal building.

During this period practically every Western State witnessed costly and extensive canal construction. A few enterprises here and there were in the hands of men who realized that the control of the land was as essential as the control of the water and that without such complete control no safe investment was possible. These men confined their operations to the irrigation of lands in private ownership, and, when equally as cautious along other lines, were in the main very successful. The majority, however, regarded lack of formal control over the lands to be irrigated as of no serious consequence, as desert land was valueless without water, and it was not believed that anyone would take up this land without taking water also. So strong and convincing were the arguments presented in favor of every phase of the undertaking that the largest projects were easily financed and surveys and construction made possible.

On most projects construction had barely commenced and on some surveys hardly had been well started before the potential value of the lands to be irrigated was fully realized and the rush to secure desirable tracts began. Some few persons applied for land in good faith, but the majority used their rights purely for speculation. The latter realized that the lands, which they could secure for practically nothing, would become very valuable property when the canal systems were completed and water made available, and that their partially perfected rights could then be relinquished to bona fide settlers at a handsome figure. In short, the land speculator and land grabber were abroad in the land. To the canal company all were "real" settlers, and the future seemed promising indeed. All went well until the canal was completed and water ready for delivery. Then, and not until then, could the speculator be distinguished from the actual settler. To the consternation of the canal company, the speculators constituted a large majority, and for the first time it was realized that a condition had been allowed to develop which spelled ruin for the enterprise. The speculator, with no idea of purchasing either water or a water right, "held down his claim," awaiting the day when some real settler would pay the price he asked for his relinquishment. With so heavy an investment in canals and structures and only a comparatively small part of the area under the system yielding revenue, pressure was brought to bear on the companies to force payment of interest and installments on the bonded indebtedness. The inevitable crisis was reached in the year 1893, and the second epoch of irrigation development in the West came to a close.

Investors, with this forcible demonstration of the dangers arising out of separate control of land and water deeply impressed upon their minds, began to seek means to prevent this condition of affairs,

The theory of irrigation investment was sound, but the speculator had to be eliminated where Government land subject to entry was involved in the scheme of reclamation.

It was absolutely essential, in order to insure future irrigation investments, that there be provided some means of vesting the control of the land in the company building the canal system. To change existing laws or boldly enact new laws was out of the question, and it was necessary to secure national legislation by more subtle methods.

Whether or not the need for such legislation was felt more keenly in Wyoming than in other States is not known, but it remained for a number of investors of that State to start the movement that resulted in the passage by Congress in 1894 of the "Carey Act," named for its introducer, Senator Joseph M. Carey, of Wyoming. This act not only marked the beginning of State and Federal aid in irrigation development, but with its subsequent amendments it has had a more far-reaching effect in producing material development in the arid West than has any other single act of national legislation bearing upon the question of public lands or irrigation.

The third epoch of irrigation development, therefore, covers the period from the passage of the Carey Act in 1894 to the present time—a period marked by the beneficial effect of national and State aid in eliminating speculative abuses and in reestablishing the principle developed in the first epoch, that joint ownership and control of water and land are absolutely essential to economic irrigation development.

THE CAREY ACT AND ITS AMENDMENTS.

The modest manner in which this important piece of legislation was secured presents a strong contrast to the far-reaching development it eventually made possible. This act, which has made possible the successful reclamation and settlement of millions of acres of desert land, was passed by Congress August 18, 1894, as section 4 of "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1895, and for other purposes" (28 Stat., 372-422), and was in fact merely a rider on a general appropriation bill. This was the case not only with the original act, but three of its important amendments were passed in the same indirect manner.

The text of the act is as follows:

SECTION 4. That to aid the public-land States in the reclamation of the desert lands therein, and the settlement, cultivation, and sale thereof in small tracts to actual settlers, the Secretary of the Interior, with the approval of the President, be, and hereby is, authorized and empowered, upon proper application of the State, to contract and agree from time to time with each of the States in which there may be situated desert lands as defined by the act entitled "An act to provide for the sale of desert land in certain States and Territories,"

approved March third, eighteen hundred and seventy-seven, and the act amendatory thereof, approved March third, eighteen hundred and ninety-one, binding the United States to donate, grant, and patent to the State, free of cost for survey or price, such desert lands, not exceeding one million acres in each State, as the State may cause to be irrigated, reclaimed, occupied, and not less than twenty acres of each one hundred and sixty-acre tract cultivated by actual settlers, within ten years next after the passage of this act, as thoroughly as is required of citizens who may enter under the said desert-land law. Before the application of any State is allowed or any contract or agreement is executed or any segregation of any of the land from the public domain is ordered by the Secretary of the Interior, the State shall file a map of the said land proposed to be irrigated, which shall exhibit a plan showing the mode of the contemplated irrigation, and which plan shall be sufficient to thoroughly irrigate and reclaim said land and prepare it to raise ordinary agricultural crops and shall also show the source of the water to be used for irrigation and reclamation, and the Secretary of the Interior may make necessary regulations for the reservation of the lands applied for by the States to date from the date of the filing of the map and plan of irrigation; but such reservation shall be of no force whatever if such map and plan of irrigation shall not be approved. That any State contracting under this section is hereby authorized to make all necessary contracts to cause the said lands to be reclaimed and to induce their settlement and cultivation in accordance with and subject to the provisions of this section; but the State shall not be authorized to lease any of said lands or to use or dispose of the same in any way whatever, except to secure their reclamation, cultivation, and settlement. As fast as any State may furnish satisfactory proof, according to such rules and regulations as may be prescribed by the Secretary of the Interior, that any of said lands are irrigated, reclaimed, and occupied by actual settlers, patents shall be issued to the State or its assigns for said lands so reclaimed and settled: *Provided*, That said States shall not sell or dispose of more than one hundred and sixty acres of said lands to any one person, and any surplus of money derived by any State from the sale of said lands in excess of the cost of their reclamation shall be held as a trust fund for and be applied to the reclamation of other desert lands in such State. That to enable the Secretary of the Interior to examine any of the lands that may be selected under the provisions of this section there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, one thousand dollars.

The original act, although of great importance in opening the way for irrigation development, was deficient in many respects, and failed to form the substantial working basis for which its advocates hoped. Acceptance of the terms of the act required special legislation on the part of the States accepting the grant, there being no specific provisions that should be followed in the original act defining the procedure. Many of the States committed serious and costly errors in framing their legislation and adopting rules and regulations to control subsequent operations. One of the first deficiencies discovered in the act was the fact that, although the State was "authorized to make all necessary contracts to cause the lands to be reclaimed and to induce settlement and cultivation," it was in no way protected in the assumption of this responsibility, nor was it in a position to protect the contractor whose funds were used in the construction of the canal system, for patent to the land under the terms of the act would

not be issued until actual operation and partial cultivation had taken place. This was a serious weakness, for, as a business proposition, it was poor policy to make a heavy investment that was utterly dependent for its safety upon the success or failure, willful or otherwise, of the prospective settler, especially when the period during which the act was in operation was limited to 10 years from the date of its passage.

Wyoming, Montana, and Colorado were the only States to accept the terms of the original act. Wyoming, because of the familiarity of its public men with the conditions leading up to the passage of the act, was in a position to enact a fairly good law, although it could not eliminate the objectionable features just mentioned. Montana, in its law passed March 18, 1895, seemed in a measure to misinterpret the meaning of the act, for provision was made for the State to undertake the reclamation and settlement of feasible projects. A commission of five, appointed by the governor, was to select the lands, appropriate the water, and pay for construction from funds received from the sales of land. Fortunately, nothing was attempted, owing to the smallness of the appropriation—\$1,000—for carrying out the provisions of the act, and no serious harm was done. To remove these obstacles to the practical working of the law, Congress, in the act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1897, and for other purposes, approved June 11, 1896 (29 Stat. 413-434), inserted under the head of appropriation for "surveying public lands," the following provision:

That under any law heretofore or hereafter enacted by any State providing for the reclamation of arid lands, in pursuance and acceptance of the terms of the grant made in section four of an act entitled "An act making appropriations for the sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-five," approved August eighteenth, eighteen hundred and ninety-four, a lien or liens is hereby authorized to be created by the State to which such lands are granted and by no other authority whatever, and when created shall be valid on and against the separate legal subdivisions of land reclaimed, for the actual cost and necessary expenses of reclamation and reasonable interest thereon from the date of reclamation until disposed of to actual settlers; and when an ample supply of water is actually furnished in a substantial ditch or canal, or by artesian wells or reservoirs, to reclaim a particular tract or tracts of such lands, then patents shall issue for the same to such State without regard to settlement or cultivation: *Provided*, That in no event, in no contingency, and under no circumstances shall the United States be in any manner directly or indirectly liable for any amount of any such lien or liability, in whole or in part.

Notwithstanding the benefit of this amendment in insuring the State and the contractor against possible loss through inability to secure title, there still remained a serious defect in the law, which prevented the fullest use being made of it. This defect was the time limit

of 10 years within which reclamation had to be accomplished, the act itself expiring by limitation 10 years from the date of its passage. This limitation really left only eight years in which the several States might avail themselves of the provisions of the act—a period altogether too short for consummating the development of projects of any magnitude. The result was that during this period only small projects that could be completed within the time limit prescribed were undertaken. Enough development was begun, however, to demonstrate the intrinsic value of the act, and steps were taken to overcome this defect, resulting in the passage of another amendment by Congress, modifying the time limitation in the original act. This important amendment also was a rider on a general appropriation bill, appearing as section 3 of the act, entitled “An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1902, and for other purposes,” approved March 3, 1901 (31 Stat., 1133–1188), which provides as follows:

SECTION 3. That section 4 of the act of August eighteenth, eighteen hundred and ninety-four, entitled “An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, and for other purposes,” is hereby amended so that the ten years’ period within which any State shall cause the lands applied for under said act to be irrigated and reclaimed, as provided in said section, as amended by the act of June 11, 1896, shall begin to run from the date of approval by the Secretary of the Interior of the State’s application for the segregation of such lands; and if the State fails within said ten years to cause the whole or any part of the lands so segregated, to be so irrigated and reclaimed, the Secretary of the Interior may, in his discretion, continue said segregation for a period of not exceeding five years, or may, in his discretion, restore such lands to the public domain.

The effect of this provision in making the ten-year period run from the date of approval of the segregation of the land and, in deserving cases, allowing the Secretary of the Interior the discretion of extending this period to 15 years, was to make the operation of the law continuous, and thereby encourage extensive development, which theretofore for sound business reasons, could not be undertaken.

It was therefore not until 1901, seven years after its original enactment, that the Carey Act assumed its rightful place of affording a complete and definite plan for the development of irrigation projects by the States, and providing adequate time for the completion of larger projects and complete security for all parties concerned. Since 1901 the provisions of the act have been extended by separate enactments as follows:

By the acts of March 1, 1907 (34 Stat., 1056), and of February 24, 1909 (35 Stat., 644), the provisions of the foregoing acts were extended to the desert lands within the former Ute Indian Reservation in Colorado.

By an act of May 25, 1908 (35 Stat., 577), an additional 1,000,000 acres within Idaho was made available for segregation.

By an act of May 27, 1908 (35 Stat., 347), an additional 1,000,000 acres of arid lands within each of the States of Idaho and Wyoming were made available for segregation.

By act of February 18, 1909 (Public, No. 244), the provisions of the foregoing acts were extended to the Territories of New Mexico and Arizona.

The only other amendment made to the act itself and to its two principal amendments was the enactment of March 15, 1910 (36 Stat., 237), which authorizes the Secretary of the Interior, upon application of a beneficiary State or Territory, "to withdraw temporarily from settlement or entry areas embracing lands for which the State or Territory proposes to make application * * * pending the investigation and survey preliminary to the filing of maps and plats and application for the segregation;" it being provided "that if the State or Territory shall not present its application for segregation and maps and plats within one year after such temporary withdrawal the lands so withdrawn shall be restored to entry as though such withdrawal had not been made."

OPERATION OF THE CAREY ACT.

The Department of the Interior, to properly administer the provisions of the Carey Act in the several States and Territories, has prescribed rules and regulations which interpret the act and its amendments and which govern the procedure of the State in its work of supervising reclamation. These regulations define the attitude of the Secretary of the Interior in deciding upon questions relative to the salient features of the act, prescribe details of procedure and requirements pertaining to the filing of maps, plats, field notes, and other data required to be submitted in applying for withdrawals, segregations, and final patents, and provide regulation forms for the submission of all data and information.

Each State and Territory accepting the terms of the grant has enacted special legislation of its own, which in most cases has been modified from time to time as exigencies arose. These State laws uniformly provide for the creating of a land board whose duties in most of the States involve the care of all State lands in addition to lands granted under the Carey Act. Each of these boards, the name varying in the different States, has developed a system of rules and regulations of its own, by which it is guided in the administration of the State law. It defines the relation of the State or Territory to the contractor, who carries out the work of actual construction, and to the settler, who enters reclaimed land.

THE CAREY ACT STATES.

The States and Territories that have accepted the terms of the Carey Act, in the order of the date of acceptance, are: Wyoming, Montana, Idaho, Colorado, Oregon, Nevada, Arizona, and New Mexico. Wyoming and Idaho have accomplished most of the development that has taken place, their combined segregated area up to date exceeding 4,000,000 acres. The principles of law and practice that have developed in these States, coincident with and as an integral part of this vast work of reclamation, form the basis for a most interesting and elaborate study. The changes which the original laws of these States have undergone since their first enactment are almost as great as the changes wrought in the virgin desert by the reclamation made possible under the act.

Three of the States mentioned, after having found that their first laws were wholly inadequate to cope with the situation presented, have repealed their original enactment and adopted new laws founded on the principles developed in other States. Failures and errors as well as successes have marked the devious development of Carey Act legislation and administration in each of these pioneer States. The progress of developing legislation and rules of administration has kept pace with reclamation, however, until now a thorough working code of laws and definite and comprehensive rules and regulations exist in most of the States, the effects of which, in their relation to development taking place, are in a way far more important than the Carey Act itself. The Federal act, it is true, made possible the extensive development of desert land, but to the States fell the onerous burden of initiating, prosecuting, and completing these developments. The laws and ruling under which this has been accomplished are, therefore, worthy of presentation.

Wyoming, Idaho, Montana, and Colorado were the first States to accept the terms of the Carey Act, each of them enacting special legislation accepting the grant in 1895. Oregon enacted its first legislation in 1901, Nevada in 1909, Arizona in 1909, and New Mexico in 1909.

As the existing laws of most of the States have been patterned after the original enactments of Idaho and Wyoming, which were nearly identical, it will be sufficient to present the salient features of the laws of those two States as illustrating the principles involved in most of the other State laws. Where unusual features have been enacted, these will be pointed out in the discussion of the different State laws:

IDAHO.

Idaho, the State making the greatest progress, accepted the terms of the Carey Act in 1895, at the first session of its legislature after the passage of the Carey Act, passing at that time a carefully drawn

law similar to that of Wyoming, passed just previously. Although ineffective in producing any considerable development, it did much toward laying the foundation for the immense development that came later. The Carey Act was new and untried, and lacked the effectiveness which its later amendments provided. After Congress passed its first amendment, June 11, 1896, authorizing the creation by the State of liens against the land for development to secure the cost of irrigation construction, Idaho, in 1899, passed a new law in which most of the features of the 1895 law were incorporated. Neither of these laws, however, resulted in any considerable development, as only three successful projects were initiated prior to 1900. The reason for this condition is not known exactly, although circumstances seem to indicate that capital would not invest in extensive undertaking because of the time limit prescribed in the national act, the Carey Act expiring by limitation in 1904. The removal of this objectionable feature by congressional action March 3, 1901, together with the phenomenal success attending the development of the Twin Falls Land & Water Co.'s project on the Snake River, initiated in 1902, just subsequent to the passage of the second amendment, served to give Carey Act reclamation in Idaho an impetus that has resulted in development that is unprecedented in magnitude and effect. Since 1901 Idaho has exhausted not only the original million acres granted to the State, but also has exhausted a second million, granted in 1908, and segregations at the present time cover the greater part of the third million acres, also granted in 1908. There has been actually expended in reclamation work alone nearly \$18,000,000, and the completion of the projects outlined will require the expenditure of between \$90,000,000 and \$100,000,000.

The control of this vast work of development, in so far as the State is concerned, is vested in the State board of land commissioners, which is authorized to make such rules and regulations as may be necessary to carry out the purposes of the national and State acts. The works are constructed under the supervision of the State and may be undertaken by any individual, association, or company. The procedure in the carrying out of a project is about as follows:

The contracting party files a request with the State board of land commissioners, asking for the withdrawal from the public domain of the lands to be reclaimed. This request, in addition to stating the lands desired to be withdrawn, must be accompanied by a proposal to construct the necessary reclamation works, stating the source of water supply, the location and dimensions of the proposed works, the estimated cost of construction, and the price and terms at which the contracting party will sell perpetual water rights to settlers. The request must be accompanied by a certificate of the State engineer to the effect that application for permit to appropriate water has been

filed in his office. The State engineer is required also to report upon the feasibility of the project as a whole. A certified check of not less than \$250 nor more than \$2,500 is required, to be held as a guarantee that the contracting party will duly execute a contract with the State in case the approval of the Secretary of the Interior is secured and the lands segregated.

If the proposed project is reported favorably by the State engineer, the board then applies for the segregation. This being granted, the State and the contractor enter into a contract which contains complete plans and specifications regarding the construction and supervision of works, and specifies the price, terms, and conditions under which water rights, and eventually the canal system, will be turned over to the settlers. The contractor gives a bond equal in an amount to 5 per cent of the estimated cost of construction for the faithful performance of his part of the contract.

The requirement that the contracting party submit maps, plans, and estimates with his request for withdrawal in theory has been an onerous one, as it necessitates the expenditure of considerable money and time by the investor before the lands are made secure from speculative entry by withdrawal. Judicious action by the board in not adhering strictly to the letter of the law and requiring only that general feasibility be shown prior to the execution of the contract, has done much, however, to help the investor proceed under this unbusinesslike provision. The act of Congress of March 15, 1910, providing for temporary withdrawal for one year pending surveys and investigations, when incorporated into the State's law, will remove this objection. The Idaho law, as do also the laws of many of the other States at the present time, contains another provision that might be improved so as to ease the burden of the investor. This provision limits the awarding by the board of any contracts requiring a greater length of time than five years for construction of works. This period is too short for large projects, especially in this day, when unavoidable delays in large construction, due to labor and other troubles, are so frequent. The investor, under this law and under the terms of the contract between him and the State, acts simply as a construction company that builds the irrigation system under the State's supervision. Although the State evades all responsibility to settlers for failure of contractors to live up to their contracts and refuses by statute to obligate itself to pay for any work or construction under any contract, at the same time it exercises the closest inspection of all work and requires absolute honest endeavor on the part of the promoter in the construction and settlement of any project, thereby fostering not only the interest of the settler individually but the interests of the State as a whole. It also guards the interests of the investor, requiring equally

honest endeavor on the part of the settler in requiring him to live up to the provisions of his contract not only with the State but with the company as well.

As soon as the lands under a project have been segregated and work inaugurated by the contractor under proper financial arrangements, the board is required to give notice by publication that the land is open for settlement, stating the price at which it is to be sold to settlers by the State, and the contract price at which settlers can purchase water rights or shares in such work. Every citizen of the United States is entitled to file upon land to the extent of 160 acres, regardless of whether or not he has exhausted his rights under the general land laws. The settler before making his application to the State board must enter into contract with the canal company for a perpetual water right for the entire acreage upon which he intends to file, and must file with his application to the State a certified copy of this contract. If the application is allowed, he is given a certificate of location which serves in lieu of title until final proof is made and patent received from the State. The land is sold to the settler by the State at the uniform price of 50 cents per acre, one-half payable at the time of entry, the other half being paid when final proof is made. A proportional part of the total cost of the canal system, plus the company's profit on its investment, is made a lien against each legal subdivision of the project. The settler in his contract for a water right agrees to pay for the water right in installments covering a period of 10 to 20 years, and the unpaid installments are a lien against the land. Within six months after water is ready for delivery the settler must establish his residence on the land. At least one-sixteenth of his claim must be cultivated within one year and one-eighth within two years. Within three years he must make final proof of having complied with these conditions, and complete payment of the purchase price of the land to the State. Upon the completion of his contract with the State he receives patent to his land, and upon completion of his payment to the canal company he receives a certificate of water right which constitutes him a shareholder in the project, his interest being one share for each acre of land owned by him. The water rights attach to the land and become appurtenant to it as soon as title passes from the United States to the State.

The amount of water to which the land is entitled has in most cases been fixed by the State board at 1 cubic foot per second for each 80 acres, measurement to be made at the point of diversion from the main canal system. Delivery is to be made at such times and in such quantities as the condition of the crops and the weather may determine. Control in the operation of the system is turned over to the settler when 35 per cent of the total lien on project lands has been

satisfied, and the ownership of the entire system passes ultimately to the settler, thereby vesting the ownership and control of the water and canals in the owner of the land.

Development under the Carey Act in Idaho has far outstripped that in other States. With conditions ideal for large undertakings, a thorough working code, and a liberal and wise-acting land board, the investment of large amounts of capital has been attracted and strides in irrigation development, heretofore unknown in the United States, have been made. Plate XXI shows two views of structures of one of the largest projects in the State. Projects completed, in process of construction, or financed at the present time contemplate the reclamation of over 2,000,000 acres and for reclamation alone involve an expenditure of more than \$75,000,000, to say nothing of the expenditure made and to be made in kindred lines of development, such as railroads, telephone and telegraph lines, and municipal improvements. The marvelous thing is that all this has been accomplished since 1903—a period of little more than eight years—and accomplished, too, with practically no trouble, discord, or litigation involving either the Government, the State, the investor, or the settler.

The following summary and table present figures on Carey Act operations in Idaho from their inception to the present:

SUMMARY.

Total area granted to the States, acres.....	3, 000, 000
Total area of segregations, acres.....	2, 630, 833
Area of reclaimed land sold to settlers, acres.....	713, 894
Area open to entry, acres.....	270, 184
Money already expended in construction.....	\$17, 562, 018
Estimated cost of reclaiming lands now segregated....	\$75, 667, 540
Amount received by State from land sales.....	\$284, 431
Average cost of reclamation per acre.....	\$28
Highest price charged for water rights, per acre.....	\$100
Lowest price charged for water rights, per acre.....	\$20
Number of projects now being developed.....	42

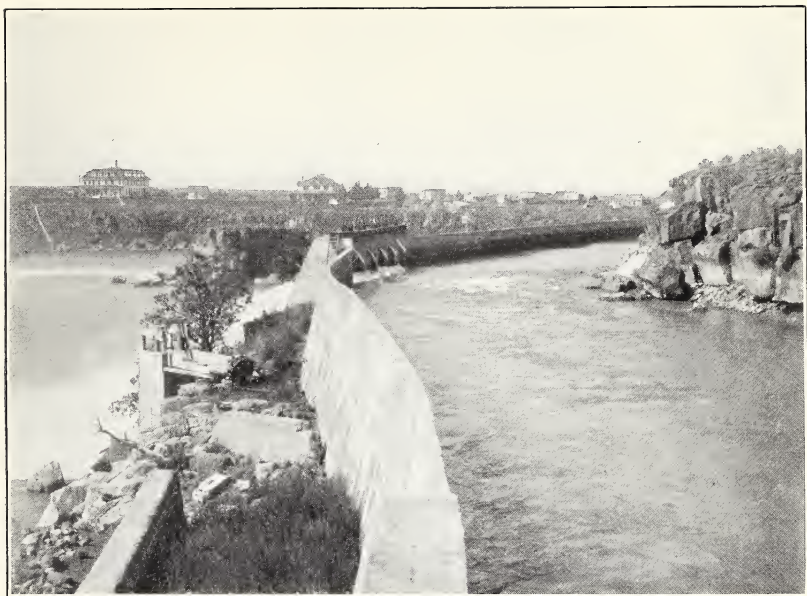


FIG. 1.—CONCRETE RETAINING WALL, NORTH SIDE OF TWIN FALLS CANAL.

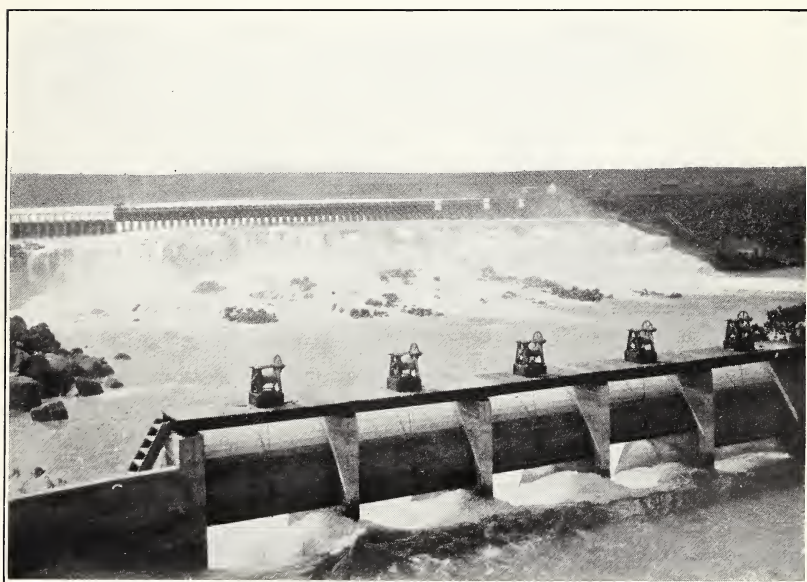


FIG. 2.—WASTE GATES, NORTH SIDE OF TWIN FALLS CANAL, MILNER DAM IN THE BACKGROUND.

Carey Act projects in Idaho, including segregations made and the applications for segregations pending.¹

Name of company.	Acreage in project.	Acreage sold.	Acreage open to entry.	Total cost of project estimated.	Amount expended to date.	Cost of water rights per acre.	Length of canal.	
							Main.	Lateral.
American Falls Canal & Power Co.....	57,306.13	46,191.42	11,114.71	\$350,000	\$911,375.00	\$40.00	Miles. 86.93	Miles. 54.85
Big Lost River Irrigation Co.....	78,241.56	60,845.37	17,396.19	3,500,000	1,600,000.00	40.00	95	100
Blaine County Irrigation Co.....	14,720	10,760	3,906	300,000	140,000.00	40.00	412	35
Boise City Project.....	180,000			20,000,000	11,640.00	2 100.00	89.36	153
Birch Creek Irrigation Co.....	22,000	3 4,000		500,000	20,000.00	-----	8	3
Bruneau Irrigation Co.....	77,000			1,330,000	30,000.00	60.00	48	32
Blackfoot North Side Irrigation Co.....	39,668.76			950,000	5,000.00	-----	35	15
Canyon Canal Co.....	5,800	5,800		300,000	700,000.00	30.00	32	60
Boise Irrigation Project.....	262,000			6,000,000	-----	40.00	40	200
Grasmere Irrigation Project.....	47,500			1,250,000	10,000.00	55.00	56	30
Grandview Extension Irrigation Co.....	1,200			75,000	15,000.00	65.00	16	2
Hegsted & Madsen Project.....	2,840			60,000	-----	-----	-----	-----
Houston Ditch Co.....	1,884	1,500	1,884	50,000	25,000.00	25.00	12	12
High Line Pumping Co.....	5,000			120,000	5,000.00	-----	9	15
Hansen, C. V.....	4,300		4,300	60,000	8,000.00	40.00	11	-----
Idaho Irrigation Co.....	128,360	77,720	50,640	4,000,000	3,000,000.00	35-50.00	100	300
Idagon Irrigation Co.....	8,814.42			590,000	74,000.00	-----	20	40
Kings Hill Irrigation & Power Co.....	12,000	10,000	2,000	600,000	600,000.00	65.00	30	15
Kings Hill Extension Irrigation Co.....	9,455	9,000	455	650,000	300,000.00	65.00	15	30
Keating, Tom., Project.....	16,500			150,000	6,000.00	30.00	5	-----
Lemhi Irrigation Co.....	7,500			200,000	-----	50.00	25	(4)
Little Lost River Land & Irrigation Co.....	65,000			400,000	6,500.00	-----	(4)	(4)
Lower Pahsimeroi.....	7,200			200,000	-----	35.00	15	-----
Marysville Canal & Improvement Co. (Ltd.).....	6,574.50	5,980.89	593.61	190,000	184,565.80	20.00	8.50	26
Owsley Carey Land & Irrigation Co.....	8,611			150,000	5,000.00	35.00	10	-----
Owyhee Land & Irrigation Co.....	29,523.03			1,000,000	16,000.00	55.00	40	160
Owyhee Irrigation Co.....	3,295	1,080	2,216	80,000	60,000.00	45.00	6	4
Pahsimeroi Project.....	43,000			942,540	-----	40.00	20	70
Portneuf-Marsh Valley Irrigation Co.....	12,000	11,000	1,000	275,000	160,000.00	35.00	26	15
Pratt Irrigation Co.....	4,674.02	2,994.07	1,679.95	125,000	42,000.00	40.00	15	70
Snake River Irrigation Co.....	6,000	1,145.25	4,854	350,000	90,000.00	50.00	8	40
T. F. L. & W. Co. (pumping).....	17,888.36			600,000	-----	-----	-----	-----
Twin Falls Land & Water Co.....	244,000	192,000	41,000	1,500,000	3,512,937.78	25.00	111.50	590
T. F. North Side L. & W. Co. (pumping).....	14,201			600,000	4,000.00	-----	31	36
T. F. Land & Water Co. (Bruneau).....	580,000			17,000,000	-----	-----	140	(4)
T. F. North Side Land & Water Co.....	239,934.36	148,235.72	71,698.64	4,500,000	3,500,000.00	30,35,45	100	625
T. F. Oakley L. & W. Co.....	45,000	28,000	7,392	1,750,000	335,000.00	65.00	30	90
T. F. Salmon River L. & W. Co.....	127,707.29	74,642.22	25,000	2,500,000	2,275,000.00	40.00	11	235
T. F. Raft River L. & W. Co.....	120,000			1,600,000	20,000.00	-----	30	50
Tabor Irrigation Co.....	21,760			300,000	10,000.00	45.00	-----	-----
Thousand Springs Land & Irrigation Co.....	6,374			20,000	5,000.00	30.50	6.50	15
West End T. F. Irrigation Co.....	46,000	23,000	23,000	500,000	175,000.00	40.00	10	6
Total.....	2,630,833.43	713,894.94	270,184.10	75,667,540	17,562,018.58	-----	1,363.79	3,128.85

¹ Fourth Annual Report State Land Department, 1910.² From author's data.³ Private entry.⁴ Surveys not yet completed.

WYOMING.

Wyoming, the first State to enact Carey Act legislation, passed its law of acceptance in 1895. Details of procedure in the matter of carrying out construction and settlement in this State and in Idaho are almost identical. The requirement that the State engineer not only approve the company's application for permit to appropriate water, but that he act as a technical judge upon the feasibility of all projects, more than anything else has served to make Carey Act development in Wyoming and Idaho stable and practically free of failures. No project is approved unless there is an ample supply of water assured, and as the system is in reality built for and its cost borne by the settler only permanent and enduring construction is permitted. Control of the works is turned over to the settlers when 70 to 90 per cent of the land is sold, and the system is thereafter operated and maintained through an organization of the settlers as stockholders.

The State sells the land for 50 cents per acre, one-half payable at the time of entry and the balance when final proof is made, the purchaser being required to contract with the company for his water right before he is allowed to enter his land.

Practically all of the larger irrigation development in Wyoming has been brought about by operations under the Carey Act, as this act affords the only means of safe investment of large amounts of capital in irrigation enterprises. The original grant of 1,000,000 acres has been segregated by the State under various projects, and the grant of the second 1,000,000 acres is nearly half gone, the segregations made and applied for covering at the present time an area of approximately 1,400,000 acres. The rate of development in Wyoming has been much more uniform than in Idaho. In the latter State the greatest development has occurred since 1906, 42 of its 46 projects having been initiated since that year. Thirty-six segregation lists had been approved in Wyoming up to and including the year 1906; 18 segregations were approved in the next two years, and 26 segregations have been received and approved during the last two years, giving a far more regular development to Wyoming's reclamation than to that of Idaho.

The following summary and table present figures on Carey-Act operations in Wyoming from their beginning to the present:

SUMMARY.

Total area granted to State.....	acres..	2,000,000
Total area of segregations.....	do....	1,390,065
Area of reclaimed land sold to settlers.....	do....	130,000
Estimated cost of reclaiming lands now segregated....		\$19,707,127
Received by State as proceeds from land sales.....		\$39,333
Average cost of reclamation, per acre.....		\$15
Highest price charged for water right, per acre.....		\$65
Lowest price charged for water right, per acre.....		\$10
Number of projects now being developed.....		63

Carey Act projects in the State of Wyoming, including segregations already made, applications for segregations now pending, and temporary withdrawals.¹

No. of list.	Canal.	Acreage.	Estimated cost of system.	Maximum price of water per acre.
1, 3	Bench	28, 729. 13	\$200, 000. 00	\$50. 00
22, 25	Oregon Basin	238, 679. 46	1, 500, 000. 00	50. 00
11, 12, 18, 19	Sidon	20, 203. 39	200, 000. 00	30. 00
17	Sage Creek Canal	784. 43	4, 000. 00	40. 00
5	John Scott	160. 00	1, 000. 00	.....
24	Boulder	6, 120. 00	8, 000. 00	30. 00
6, 9	Cody	24, 562. 55	200, 000. 00	50. 00
.....	John H. Fitzsimmons	160. 00	1, 000. 00	.....
16	Fisher	320. 00	2, 500. 00	10. 00
28	Hanover	10, 682. 53	225, 000. 00	50. 00
15	Cody & Salsbury (south of river)	11, 767. 93	.....	.....
21, 31, 45	Big Horn Co. Canal	16, 295. 44	360, 000. 00	.....
20	North Platte Canal & Colonization Co.	4, 602. 23	70, 000. 00	30. 00
29	French Creek	18, 869. 29	(²)	.....
26	Lovell Irrigation Co.	7, 920. 51	100, 000. 00	25. 00
30	Platte Valley Canal (not constructed; land to be relinquished)	18, 171. 27	50, 000. 00	30. 00
31	Big Horn County Irrigation Co., additional	4, 624. 42	50, 000. 00	50. 00
32	Wheatland Industrial Co.	8, 087. 02	46, 500. 00	45. 00
33	Sahara Ditch Co.	7, 920. 39	98, 493. 00	50. 00
34	La Prele Reservoir & Ditch Co.	15, 077. 34	154, 000. 00	50. 00
35	Eden Irrigation & Land Co.	56, 322. 74	100, 000. 00	30. 00
36	Medicine Wheel Canal Co.	22, 522. 64	200, 000. 00	30. 00
37	Eden Canal	39, 335. 40	400, 000. 00	30. 00
38	North Platte and Encampment (to be relinquished)	30, 387. 32	1, 000, 000. 00	.....
39	Hubbard	38, 604. 58	400, 000. 00	40. 00
40	Paint Rock	42, 600. 34	600, 000. 00	50. 00
41	La Prele, additional	4, 784. 66	1, 300, 000. 00	50. 00
42	Wheatland, additional	3, 076. 21	500. 00	45. 00
43	Hammit Ditch	6, 295. 01	80, 000. 00	50. 00
44	Paint Rock	10, 562. 02	100, 000. 00	50. 00
45	Big Horn County Canal	506. 03	.....	.....
46	Elk Canal	2, 724. 49	30, 000. 00	30. 00
47	Reynolds or Hemingway Reservoir	320. 00	10 600. 00	30. 00
48	La Prele, additional	160. 00	.....	.....
49	Green River Land & Irrigation Co.	75, 295. 92	1, 800, 000. 00	35. 00
50	James Lake	14, 543. 65	300, 000. 00	35. 00
51	Tensleep & Bonanza Canal	16, 544. 18	218, 750. 00	40. 00
52	Wheatland Industrial Co.	21, 991. 72	97, 140. 00	43. 00
53	K. F. McDonald	15, 544. 18	245, 000. 00	50. 00
54	Hawks Springs project	12, 437. 56	136, 530. 00	50. 00
56	Carbon County Land & Irrigation Co.	7, 300. 00	150, 000. 00	30. 00
57	Uinta County Irrigation Co.	26, 080. 00	120, 000. 00	35. 00
58	East Fork Irrigation Co.	4, 901. 50	15, 000. 00	30. 00
59	Bertram Ditch	588. 33	5, 000. 00	30. 00
61	Shell Canal (Wyoming Land & Irrigation Co.)	4, 526. 12	100, 000. 00	50. 00
62	Highland Canal (Fremont Lake Irrigation Co.)	5, 199. 28	30, 000. 00	25. 00
63	Snow Ditch No. 2 and Reservoir	1, 397. 92	13, 000. 00	30. 00
64, 78	High Line Ditch (North Platte Valley Irrigation Co.)	11, 176. 61	90, 000. 00	50. 00
65	Irvine Canal (North Platte Valley Irrigation Co.)	4, 320. 00	51, 000. 00	50. 00
66	Glendo Canal (North Platte Valley Irrigation Co.)	6, 826. 62	50, 000. 00	50. 00
67	Sierra Madre Canal & Reservoir Co.	25, 644. 70	651, 116. 00	50. 00
68	North Laramie Canal Co.	4, 133. 03	22, 000. 00	30. 00
69	Sixty-seven Reservoir	2, 160. 00	10, 000. 00	30. 00
70	Uinta Development Co.	16, 849. 35	245, 000. 00	30. 00
71	Rock Creek Conservation Co.	11, 695. 75	563, 388. 00	45. 00
72, 79	Big Bend Reservoir Co.	25, 870. 94	742, 629. 00	50. 00
74	Wyoming Central Irrigation Co.	333, 000. 00	7, 000, 000. 00	38. 75
75	Kirby Canal (Thermopolis Investment & Irrigation Co.)	2, 383. 55	21, 106. 50	35. 00
76	Johnson Irrigation Co.	13, 770. 94	300, 000. 00	65. 00
77	French Creek Irrigation Development Co.	5, 288. 72	40, 000. 00	50. 00
80	Fremont Lake Irrigation Co.	3, 596. 92	(⁵)	(⁶)
81	Riverside Irrigation Co. (Tremont Canal)	8, 993. 98	198, 875. 00	30. 00
82	Riverside Irrigation Co.	6, 065. 99	(⁵)	.....
Total		1,390,065.00	19,707,127.00	.....

¹ Biennial Report, 1909-10, Commissioner of Public Lands, State of Wyoming.

² Unknown.

³ No contract; entire system.

⁴ Entire system.

⁵ Temporary withdrawal.

⁶ Cost not ascertained.

MONTANA.

The terms of the Carey Act were first accepted by Montana by act of March 18, 1895. The intent of this early act was very different from the first acts passed by Wyoming and Idaho in the same year in that it embraced the idea of reclamation and settlement of lands by the State itself. A commission of five residents of the State, appointed by the governor, was empowered to select lands, appropriate water, and pay the necessary expenses incurred with warrants drawn on the State. Subsequent expenses of reclamation and colonization were then to have been met by the proceeds from sales of land under the projects that were constructed. Fortunately, the original appropriation carried by the act, \$1,000, was wholly inadequate to initiate such vast operations and nothing was accomplished. At the next session of the legislature, in 1897, the first law was repealed and a much more elaborate one enacted. Power was vested in a newly created body known as the "State arid land grant commission," and many of the objectionable features of the 1895 law were remedied. The theory of reclamation by the State was retained, however, and all expenses were to be met by State warrants based upon future land sales under projects. Again a precarious situation was prevented by the appropriation being so small that the commission could not accomplish any considerable results toward actual development. On March 8, 1905, the legislature repealed the 1897 law, abolished the State arid land grant commission and permanently abandoned the idea of reclamation by State. A law was enacted at that time which embodied the main features of the laws of Wyoming and Idaho. This law, with some minor modifications, is in effect at the present time.

The administration of the present law is vested in the "Carey Land Act Board" composed of the State engineer, secretary of state, and State examiner, none of whom receives additional compensation for such service. The State engineer holds the most responsible position, as no action of the board is binding without his ratification. In addition to his duties as a member of the board, he is required to pass upon all projects and exercise general supervision over all construction.

The importance and magnitude of Carey Act development having reached a stage where the duties of administration are more than the several members can cope with successfully, in addition to their regular duties, it was recommended by the board and the State engineer in their last biennial report (1909-10) that a new board be created, whose entire time could be devoted to Carey Act work, and that the State engineer should be relieved of active membership on the board and should act merely in a clerical capacity as secretary. This would

enable him to devote more time to field investigations and relieve him of the responsibility of acting as a board member upon his own recommendations as State engineer upon the various matters connected with Carey Act operations.

The laws, rules, and regulations of Montana are very similar to those of Wyoming and Idaho in matters of administration relative to making segregations, operations of construction companies, and procedure of the settler in securing possession of lands and water rights under projects. Montana's water laws are not so effective as those of Wyoming and Idaho, where certificates of permits to appropriate water are required before segregations are applied for by the State. It is therefore provided that the statement of "water available" shall be substantiated by the presentation of the data from which the amount of "water available" was determined. The State is not obligated to pay for work of subcontractors, or responsible to settlers for failures that may occur in spite of careful supervision exercised. The price at which the land is sold to entrymen is placed at 50 cents to \$1 per acre, the full amount payable at time of entry. When the number of water rights sold and paid for reach a specified percentage of the total water rights under a project (not to exceed 90 per cent in any case) the control and operation of the project is turned over to the settlers. This percentage is variable and is fixed by the board in each case at the time of entering the contract with the company.

Special features of the Montana law are as follows: By paying all costs and fees any person wishing to reclaim land under the Carey Act may, by applying to the board, have the State engineer make a reconnoissance or preliminary survey of the project proposed to be developed. In this way preliminary official approval may be had of any project without the expense of a private survey and investigations which must afterwards be gone over by the State engineer.

Cooperative reclamation projects initiated and constructed by the settlers themselves are specifically authorized by law. Such organizations shall be incorporated as "cooperative irrigation associations," and each member shall subscribe to one share of stock for each 40 acres of land to be filed upon by him. It is the duty of the State engineer to investigate the project proposed, and if found feasible to prepare the necessary maps for securing the segregation and subsequently to prepare the necessary plans and specifications and exercise general supervision over their execution. No charge for this work is made other than a filing fee of 25 cents for each acre reserved. Procedure in the matter of settlement, cultivation, and securing of title is the same as for other types of projects.

To expedite settlement on any project the board is authorized to lease or otherwise permit reclaimed lands to be improved, occupied,

and cultivated for limited periods. Such temporary occupancy, however, does not prevent any other person entering such lands as prescribed by law.

Builders of projects are given the right to so construct or enlarge irrigation works as to permit the water to be used for power purposes, and are granted the right to use any surplus water for developing power, the income from which belongs to the builder for all time.

The "office and clerical expenses" of the board are made a charge against all projects, being apportioned at the end of each year among the various districts and projects receiving benefit.

Development in Montana under the Carey Act has been confined almost wholly to the period since the passage of the 1905 law. Prior to that time the efforts of the old arid land grant commission, misdirected as they were, resulted in deplorable failure, and it would have been better had such operations never been undertaken. Only three of the thirteen successful projects initiated in the past six years are in stages of actual development. The remaining ten are in preliminary stages, and as yet no construction work has been begun on them. It is a noticeable fact that seven of the thirteen projects are to rely upon storage reservoirs to insure an adequate water supply.

The following summary and table present figures on Carey Act operations in Montana from their beginning to the present:

SUMMARY.

Total area granted to State.....	acres.....	1, 000, 000
Total area of segregations.....	do.....	411, 326
Area of reclaimed land sold to settlers.....	do.....	45, 000
Total area of reclaimed land.....	do.....	70, 000
Number of projects being developed.....		13

Carey Act projects in Montana, including segregations and applications for segregations now pending.¹

List Nos.	Company promoting projects.	Segregations.
		<i>Acres.</i>
1 and 7	Billings Land & Irrigation Co. (approved).....	15,378. 11
2 and 3	Glass-Lindsay Land Co. (approved).....	19,098. 51
9 and 11	Glass-Lindsay Land Co. (unapproved).....	13,549. 32
5 and 6	Great Falls Land & Irrigation Co. (approved).....	36,536. 42
8	Conrad Land & Water Co. (approved).....	70,133. 56
12 and 14	Conrad Land & Water Co. (unapproved).....	32,764. 71
10	Teton Co-Operative Reservoir Co. (unapproved).....	134,987. 42
13	T. T. Black and F. H. Ray (unapproved).....	20,308. 87
15	Withee, Cargill, and Edgerton et al. (unapproved).....	5,142. 30
16	R. A. Carnochan et al. (unapproved).....	22,285. 96
18	Red Rock Reservoir & Irrigation Co. (unapproved).....	7,885. 52
21	MacGinnis, Hilger et al. (unapproved).....	13,611. 20
22	H. R. Albion et al. (unapproved).....	19,644. 97
	Total acreage.....	411,326. 87

¹ Biennial Report, 1909-1910, Carey Act Land Board, State of Montana.

OREGON.

Acceptance of the terms of the Carey Act by Oregon was authorized by act of February 28, 1901. A loosely drawn, poorly administered law served to give Oregon a bad start with its Carey Act development. A "State land board," consisting of the governor, secretary of state, and State treasurer, was charged with the administration of the law. There was no State engineering department nor State engineer at that time; neither was there any officer charged with the control of the water supply of the State, so that technical advice in matters of engineering and water supply, so absolutely essential in the administration of the Carey Act, was not available, even had the board desired the benefit of it. The board assumed more the attitude of an irresponsible agent than anything else, acting simply as an intermediary for the transaction of business between the promoter and the Department of the Interior. The policy of the board was to approve all projects presented to it, without thorough investigation, in order to get them before the Department of the Interior for inspection, the assumption being that it was the province of the department and not of the board to pass upon the feasibility of plans, supervise construction, and in short attend to all details. This was at a time when the requirements of the department were much less exacting than at present, and consequently many projects were contracted in Oregon that never should have been undertaken, and a number of projects that would have been successful had proper control been exercised from the beginning were allowed to get into straits from which they have been rescued with difficulty.

The office of State engineer was created in 1905. A ruling by the Department of the Interior about the same time, construing that part of the original act requiring that an ample supply of water be actually furnished, provided that before segregations should be made or patents issue to any State there should be submitted by the State engineer a statement, under oath, that the water supply and completed works were adequate for the lands reclaimed. This combination of circumstances, aided by the appointment of a man as State engineer who believed that the State in acting as agent for the future settler should be—as the law intended—a responsible agent, resulted in a most desirable change of policy on the part of the State land board. For the first time the public, the settler, and the company received equal consideration in all matters concerning land reclamation. No longer were the construction companies permitted to arrange matters looking to their own interests only. Each case received close scrutiny, and every effort was put forth to see that the intent of both the National and State acts were fully car-

ried out. Errors of the past required attention, and remedial measures were undertaken. Faulty contracts were canceled whenever possible and modified contracts substituted in cases where it was evident that construction already undertaken would prove a loss to the investor who had been permitted to initiate his project without sufficient investigation.

Under these changed conditions the inadequacy of the State law became more noticeable than ever. Lack of sufficient authority conferred by law, absence of an effective water code on the statute books, and no appropriation to cover necessary expenses handicapped the operations of the board. Efforts were put forth, therefore, to secure more adequate legislation and a working appropriation. This resulted in the passage of a modern water code and also a new Carey Act law, the old law of 1901 being repealed. The new law, passed February 24, 1909, embraces the desirable features of the Idaho and Wyoming laws. The selection, management, and disposal of all lands and the control of all reclamation was vested in the desert-land board, which consists of the governor, secretary of state, State treasurer, attorney general, and State engineer. The governor and State engineer are chairman and secretary, respectively. Administration, regulation, and control of settlement and reclamation are much the same as provided in Wyoming and Idaho. Peculiar conditions, however, required the introduction of some new features which are interesting.

The old law provided for no appropriation for the State land board, neither did it require the settler to pay anything for the land upon which he settled, although the Carey Act specifically authorizes the States to "sell" these lands. As the construction company also was not required to make any payments to the State, there was no revenue with which to meet the expenses of the board. This condition was remedied in the new law by requiring the company to pay to the desert-land board \$1 for each acre for which a water right has been sold. This payment is to be made from the first installment of lien received by the company from the settler. These payments are credited to the "reclamation fund," to be used in defraying expenses authorized by the board.

Under the new law the lien price is fixed by the board in the final contract as the actual cost of construction plus 75 to 100 per cent profit. The final contract is not executed until after the preparation by the company of complete plans and specifications of the entire project. The preliminary investigations are surveys being carried out under a temporary contract with the State that is subsequently replaced by the final contract.

A unique feature is the provision authorizing the board to secure the withdrawal of land on its own behalf and to let contracts to the



FIG. 1.—MAIN CANAL HEADWORKS, DESCHUTES IRRIGATION AND POWER COMPANY, DESCHUTES, OREG.

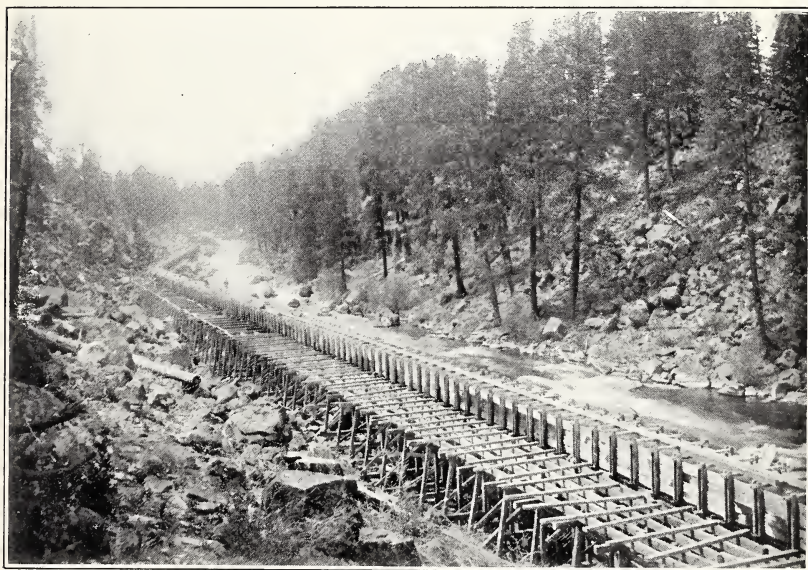


FIG. 2.—MAIN CANAL FLUME OF DESCHUTES IRRIGATION AND POWER COMPANY IN PROCESS OF ENLARGEMENT.



lowest responsible bidder for the reclamation and colonization of those lands when withdrawn. No projects have been initiated in this manner as yet, and the value of this feature therefore is not known. It is sound in theory, however, and if properly administered might prove an advance in Carey Act legislation that could be adopted with profit by other States.

Under the old law title to the irrigation system remained perpetually with the company, the settler paying the company a fixed sum each year for the maintenance and delivery of the water. This feature of separate ownership of land and water was eliminated with the passage of the new law, and now it is required that within 10 years from the date of the contract—time specified in each contract—the control and management of the system shall be turned over to the purchasers of water rights, the contractor retaining an interest proportional to the amount of water unsold. To insure to the settler the transfer of the system in good condition and repair, the contractor is required to make a deposit, usually \$1 per acre, when the settler makes application for his entry, this deposit to be returned by the board at time of transfer if the system is in good condition. The title received by the settler from the State, when the full lien is satisfied and final proof made, is in the form of a quitclaim deed, conveying only such title as the State may have in the lands conveyed.

About 20 different projects were initiated soon after the passage of the old law in 1901. Only 2 of these have been carried to successful completion. Nearly all of the remaining 18 failed outright because of the conditions already referred to. A few of the original undertakings have been reorganized and are making headway, but the stigma of ineffectual State management remains upon most of the earlier projects. For a period of five years prior to the adoption of the new law in 1909 no new projects were initiated. This was due in large measure to the attitude of the board in withholding approval of projects in cases where there were uncertainties as to water supply, there being at that time no adequate water legislation to make possible the determination of the amount of unappropriated water in the various streams of the State. With the concurrent passage of the new Carey Act law and the new water code in 1909, the final obstacles to normal and healthy development were removed, and in the past two years reclamation under the terms of the Carey Act has been greatly stimulated. Plate XXII shows structures on the largest Carey Act project in the State.

The following summary and table present figures on Carey-Act operations in Oregon from their inception to the present time:

SUMMARY.

Total area granted to State.....	acres.....	1, 000, 000
Total area of segregations contracted for, applied for, and withdrawn temporarily.....	acres.....	593, 124
Total of segregations contracted for.....	do.....	295, 350
Total for which applications are pending before General Land Office.....	acres.....	87, 178
Total temporarily withdrawn from entry.....	do.....	210, 566
Minimum lien authorized in any project.....		\$10
Maximum lien authorized in any project.....		\$60
Number of projects now being developed.....		16

Carey Act projects in Oregon, including segregations made and applied for and lands temporarily withdrawn from entry.¹

List No.	Company promoting project.	State of development.	Acres segregated and applied for.	Lien per acre fixed by board.	Annual maintenance per acre.
1	The Portland Co.....	Segregated.....	8,793	\$10. 00	\$1. 50
3	Brownell Desert Reclamation Association (cooperative).	Deeded.....	240		
4	Deschutes Reclamation & Irrigation Co.	Segregated and partly deeded	1,280	4. 00	. 50
6-19	Deschutes Irrigation & Power Co.....	.....do.....	140,714	$\left\{ \begin{array}{l} \text{2} 2. 50 \\ \text{3} 40. 00 \end{array} \right\}$	1. 00
20	.....do.....	Segregated.....	74,198	$\left\{ \begin{array}{l} \text{2} 2. 50 \\ \text{3} 60. 00 \end{array} \right\}$	
11	Deschutes Land Co.....	.....do.....	31,082	36. 00	. 50
13	Columbia Southern Irrigation Co.....	Segregated and partly reclaimed.	27,004		
15	Portland Irrigation Co.....	Segregated.....	12,037	35. 00	. 50
24	Jordan Valley Irrigation Co.....	Segregation applied for.....	37,870		
25	Harper Valley Irrigation Co.....	.....do.....	15,132		
27	Eastern Oregon Irrigation Co.....	.....do.....	21,704		
29	Deschutes Irrigation & Power Co.....	.....do.....	12,470		
28	Powder Valley Irrigation Co.....	Temporarily withdrawn.....	44,075		
29	C. C. Cottrell, trustee.....	.....do.....	9,120		
31	Warner Lake Irrigation Co.....	.....do.....	150,000		
32	Oregon, Washington & Idaho Finance Co.	.....do.....	7,401		
	Total.....		593,124		

¹ Report Desert Land Board, 1909-10, State of Oregon.² Waste land.³ Irrigable land.

COLORADO.

Colorado accepted the terms of the Carey Act in 1895, in the same year as Wyoming, Montana, and Idaho. This original enactment of 1895, like the early laws of other States, was ineffectual in promoting development, and but little was accomplished. The original law remained on the statute books for 12 years and was then superseded by the amendatory act of April 9, 1907, which is now in effect. Under the terms of this act rapid development is taking place. The general provisions of the law are practically the same

as those of Wyoming and Idaho, but it is not as carefully framed nor as exhaustive as the laws of those States, and no doubt will require future modifications and additions to make it an effective working code.

In the 14 years subsequent to the passage of the original act in 1895 there were only six projects initiated, and of these only two received the approval of the Department of the Interior. Development under the Carey Act in Colorado has therefore been confined almost entirely to the last two years. At the present time there are six approved projects in various stages of development, under which the work of reclamation and settlement is being successfully carried on. In addition to these there are 14 projects in the initial stage, awaiting the approval of their segregations by the Department of the Interior.

The following summary and table present figures on Carey-Act operations in Colorado from the beginning to the present time:

SUMMARY.

Total area granted to State, not including Ute Indian Reservation grant.....	acres.....	1, 000, 000
Total area segregated, contracted, and applied for.....	do.....	1, 121, 940
Area of reclaimed land sold to settlers.....	do.....	34, 000
Number of projects now being developed.....		20

Carey Act projects in Colorado, including segregations made and applied for.

List No.	Company promoting project.	State of development.	Acreage in project.	Acreage sold.	Cost of water rights.
			<i>Acres.</i>	<i>Acres.</i>	
1	Routt County Development Co...	Segregated and partly sold..	39,000	7,000	\$45
6	Colorado Land & Water Co.....	do.....	16,000	6,000	45
7	Two Buttes Irrigation & Reservoir Co.	do.....	22,000	20,000	35
10	Toltec Canal Co.....	do.....	16,000	1,000	45
11	Valley Investment Co.....	Segregated.....	24,000		
15	Great Northern Irrigation & Power Co.	do.....	18,000		
8	Pawnee Irrigated Land Co.....	Segregation applied for.....	6,500		
9	South Palisades Fruit, Land & Water Co.	do.....	13,000		
12	Williams High Line Canal Co.....	do.....	30,000		
16	White River Project.....	do.....	285,000		
18	San Miguel Canal Co.....	do.....	75,000		
19	Browns Park Water Co.....	do.....	25,000		
22	Huerfano Valley Co.....	do.....	40,000		
23	N. Montgomery.....	do.....	26,000		
25	Colt project.....	do.....	40,000		
26	Stark Hagadorn.....	do.....	28,000		
27	Happy Home Reservoir Co.....	do.....	44,000		
28	Blue Mountain Irrigation Co.....	do.....	177,320		
30	White River project.....	do.....	196,000		
31	L. W. Hughes.....	do.....	1,120		
			1, 121, 940	34, 000	

NEVADA.

The law under which the Carey Act operations are conducted in Nevada at present was passed March 23, 1909. This law requires the State land register to examine all lists and proposals and "ascertain if they comply with the regulations of the Department of the Interior and rules of the State land office." If so, they are submitted to the State engineer, who is required to report on the feasibility of the project as a whole, the adequacy of the proposed water supply, the "reasonableness" of the proposed cost of construction, and the character of the land to be reclaimed. If such report can not be made from the data presented by the investor, the State engineer is authorized to make the necessary investigations in the field. Upon receiving a favorable report from the State engineer the State land register is required to request the selection on behalf of the State of the lands applied for. It is the policy of the State engineer, under the provisions of the act of Congress of March 15, 1910, permitting temporary withdrawals for one year pending surveys and investigations, to recommend all applications for withdrawal where a cursory examination reveals the probability of there being a sufficient water supply available. Before recommending segregation at the end of the period of temporary withdrawal, however, the State engineer requires that under his direction the applicant shall make such necessary surveys and investigations as are necessary for the making of definite recommendations. The law is most meager in essential details, and provides only in a general way for the administration of the provisions of the national act. The entire responsibility of preserving the welfare of the public, the settler, and the investor is placed upon the State engineer alone, and is a burden too great for one man, especially when such burden is in addition to the regular duties of his office. In this essential at least the Nevada law needs early modification. Other States have found that carefully drawn legislation and effective administration are important factors in promoting Carey Act development and insuring its success. Nevada should profit by this experience and pass the legislation needed to insure steady and permanent development of its desert lands.

The value of the Carey Act in promoting the development of desert lands has not yet been fully realized by Nevada. No active reclamation or settlement has as yet taken place, and such projects as have been initiated are only in their preliminary stages. The first lists submitted for approval by the State were all rejected by the Department of the Interior on the ground that the segregations applied for, consisting of only 160 to 360 acres, were too small to bring them within the intent of the act, it being held that the entry of such

small tracts came properly under either the Homestead Act or the Desert-land Act.

The first application for segregation in Nevada—List No. 9, that was approved—was approved by the Department of the Interior May 28, 1910. Since that time much activity has been displayed. One other segregation has been secured and construction work commenced. The remaining projects are in their preliminary stages.

An interesting problem has arisen in connection with the application for five projects to be irrigated from artesian sources. These projects were reported favorably by the State engineer, and the State land register applied for their segregation. The General Land Office held all these for rejection, the specific reason for such action being as follows:

The object of the Carey Act is not to interfere with the existing laws of the United States affecting the disposal of land to individuals.

The obvious intent of the Carey Act was to segregate to the States large tracts of desert lands which could not, because of the magnitude of the undertaking, be successfully irrigated by individual effort. Nor would it seem to be good administrative policy to allow the Carey Act to encroach upon the province of the Homestead and Desert-land acts.

The Government would thus lose the payment required by the latter act, and the entryman would not be required to make the expenditure and cultivation required by the Desert-land Act.

Nowhere does it appear from the record that the reclamation of these tracts could not be effected through desert-land or homestead entry.

The State engineer submits a plan showing the wells in the vicinity; from this it appears that flowing wells are struck at a mean depth of about 200 feet; the best well is at a depth of 325 feet.

Upon the face of the record, it would seem that the water was within the reach of the ordinary farmer and that the land could be reclaimed much more expeditiously under the Homestead or Desert-land acts.

In practical effect, reclamation without recourse to the Carey Act would be more profitable, both to the Government and to the ultimate purchasers; the Government would secure the payment of \$1.25 an acre, while the purchaser would be spared the promoter's profit.

The State took an appeal from this decision of the General Land Office, and final action is still pending.

The following summary and table presents figures on Carey-Act operations in Nevada from their beginning to the present time:

SUMMARY.

Total area granted to State.....	acres..	1, 000, 000
Total segregations, contracted, applied for, and temporarily withdrawn	acres..	173, 215
Number of projects awaiting development.....		13

Carey Act projects in Nevada, including segregations made, applied for, and projects for which land has been temporarily withdrawn.

List No.	Company promoting project.	Stage of development.	Acreage in project.	Source of water supply.
			<i>Acres.</i>	
9	Pacific Reclamation Co.....	Segregated.....	10,246	Natural streams.
10	Las Vegas Irrigated Fruit Lands Co.	Held for rejection by General Land Office. Now on approval.	8,857	Artesian wells.
11	Las Vegas Farming Lands Co.....	.....do.....	7,523	Do.
12	Charles S. Wilkes.....	.....do.....	2,404	Do.
13	Las Vegas Irrigated Lands Co.....	.....do.....	6,800	Do.
14	Amargosa Land & Irrigation Co.	Segregated.....	17,705	Artesian wells and surface flow.
15-16	Vegas Valley Land Co.....	Held for rejection by General Land Office. Now on approval.	6,717	Artesian wells.
17	Pahrump Valley Land & Water Co.	Temporary withdrawal.....	13,440	Do.
18	E. C. McClellan & W. T. Smith.....	.....do.....	27,978	Natural stream.
19	Ellison Ranching Co.....	.....do.....	50,184	Do.
20	De Witt C. Turner.....	Recommended for temporary withdrawal.	6,230	Do.
21	Loveland Land & Development Co., and Humboldt-Lovelock Irrigation, Light & Power Co. (Inc.).	.....do.....	10,175	Do.
22	Western Development Co.....	.....do.....	4,956	Do.
	Total.....	.....do.....	173,215	

¹ Biennial Report of State Engineer, 1909-10, State of Nevada.

THE VALUE OF THE CAREY ACT.

Most of the national land laws, designed as they were originally to promote the development of land in the humid and semihumid sections of the United States, were of little value in encouraging development in the Western States where arid conditions existed. The entryman in the Mississippi Valley, by his unaided efforts, could develop his land and cause it to produce abundant crops. The effort of the entryman in the arid region to make a living and carry out the intent of the law governing his entry was bound to be a failure, however, unless he was fortunate enough to secure a tract of land along some stream where water for irrigation was easily made available, for without water the land was absolutely unproductive, and an area ten times that permitted under the land laws would not provide even a bare existence. The natural result of this condition was that the easily developed land lying in narrow strips along the natural streams was taken up under the homestead and other laws, and when this land was all occupied further settlement ceased. The existing land laws proved entirely unfitted for conditions in the arid region, and therefore the next step was the passage of the desert land act in 1877 (19 Stat., 377), which permitted the acquiring of not to exceed 640 acres of land by actually irrigating it and paying the Government \$1.25 per acre. This law was amended in 1891. (26 Stat., 1095.) Under the amended law the maximum area that can be acquired by one person is 320 acres; it is required that \$1 per acre

be spent during each of the first three years in reclaiming the land, and that \$1.25 per acre be paid the Government, 25 cents being due at time of filing and the other \$1 at the time of final proof, which may be any time between the end of the third and the fifth years. These laws served to bring about the development of the remaining land along streams that could be reclaimed easily, and there their usefulness ended. Their provisions, when put to the test, availed nothing in the way of developing the broad expanse of fertile land lying back from streams, and resulted in little more than extensive "wild catting" and disastrous land and water speculations. The passage of the Carey Act and its amendments marked the real beginning of substantial settlement and reclamation of the vacant Government lands of the West, and the vital principles controlling sound and progressive arid-land development were for the first time incorporated in national land legislation.

The most important feature of the act is its recognition of necessity of common control and ownership of land and water. This through wise legislation and administration on the part of the States, eliminates all forms of land speculation and the evils arising therefrom, and makes the owners of the land the ultimate owners of the canal system.

Another feature which indirectly has worked much good is the requirement that there be an adequate water supply for the lands to be reclaimed. This feature was not enforced as it should have been in the early years of Carey Act operations, owing to the lack of definite data regarding water supply. Some complications arose from this condition of affairs, but these are being remedied. The States that had adequate water codes, notably Wyoming and Idaho, experienced no such difficulty, and these States, it will be noticed, have made the greatest advances. The later enforcing of this provision regarding water supply has had the effect, as in Oregon, of securing enlightened water legislation, which has not only stimulated Carey Act development, but has vastly benefited the State as a whole in numerous other ways.

State supervision in the matter of securing segregations, prosecution of construction, and in the settlement and cultivation of the land not only favors the investor and the settler, but promotes the public interest as well. Under proper administration none but successful projects can be undertaken. This secures the investor, whose money is expended in the construction of the project. He knows what it will cost to build the system and also what he will receive for water rights when the system is completed, and he knows that the State will require the settler to make all of his payments promptly and in full. The settler secures land cheap, and purchases his water right at moderate rates on long-time contracts. His water supply is

assured and he becomes eventually a part owner of the irrigation system. The public interest is promoted by the development of vast areas of unproductive land that add greatly to the wealth and prosperity of the State as a whole.

The Carey Act has proven a most powerful factor in the upbuilding of the West despite the fact that the original act of 1894 was inadequately drawn and required subsequent amendments to make it effective and that as a result early State legislation was likewise defective. It has been directly responsible for the initiation of 167 irrigation projects. These projects are in various stages of development, some of them have only temporary withdrawals of lands, many are only barely begun, while some are completed and others are nearly completed. Under these projects land actually reclaimed has been entered by settlers to the extent of practically 1,000,000 acres. The following table shows the development in the West under the provisions of the Carey Act:

Development accomplished in the West under the provisions of the Carey Act.

State.	No. of proj- ects.	Area granted by United States.	Area segre- gated and segregations pending.	Additional area tem- porarily withdrawn from entry.	Area entered by settlers and being developed.
		<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Idaho.....	42	3,000,000	2,630,833	.....	713,890
Wyoming.....	63	2,000,000	1,380,402	9,663	130,004
Oregon.....	16	1,000,000	382,528	210,596	54,000
Montana.....	13	1,000,000	411,326	.....	45,000
Colorado.....	20	¹ 1,000,000	1,121,940	.....	34,000
Nevada.....	13	1,000,000	60,252	112,963	.....
New Mexico.....	.....	1,000,000	16,000	.....	.....
Total	167	10,000,000	6,003,281	333,222	976,894

¹ Exclusive of Ute Indian Reservation.

This is a most striking demonstration of the value of the Carey Act as a factor in promoting the upbuilding of the West. That its value will continue to become more and more manifest goes without saying, for with the gradual improvement in State legislation and State administration in those States where development is only beginning, results similar to those already accomplished in Idaho and Wyoming will inevitably follow.

DEVELOPMENT OF METHODS OF DRAINING IRRIGATED LANDS.

By C. G. ELLIOTT, *Chief of Drainage Investigations.*

INTRODUCTION.

The necessity of draining irrigated lands in the arid sections has become apparent to those who have been intimately associated with their reclamation and subsequent management. The subject has a peculiar significance to the owners of lands which have succumbed to the inroads of seepage, as excessive moisture is usually called, many acres of which have been abandoned by the owners and are no longer classed as productive property. The fact that large areas of excellent farming and high-priced fruit land have been ruined or seriously injured in each of the States where irrigation is practiced furnishes a sufficient reason for making a careful examination of the methods which have been developed through the efforts of engineers and experts of this office for preventing the extension of such injury in localities where evidences of it appear and of restoring such lands to a productive condition. (Pl. XXIII, fig. 1.) One of the serious and distressing features associated with seeped irrigated land is that a highly productive and prosperous ranch may often be found adjoining another which has been seriously injured or wholly ruined by seepage, both having been reclaimed at the same cost and which were originally equal in productive value. The oft-repeated statement that the condition of the latter is due to careless or unskillful management on the part of the owner is not usually sustained by the facts in the case. The seepage of land is more often due to natural conditions which exist beneath the surface, the effect of which can not be anticipated, than to any indications which are visible at the time the land is first watered. Hence the keen disappointment which the owner feels when seepage and, in some cases, alkali attacks portions of his ranch, and it is not surprising that he casts about for some remedy or possibly abandons the field to salt-grass pasture, alkali bog, or, in the later stages of saturation, to the tule swamp. The hardship which such conditions work upon the less fortunate owner is easy to see, and suggests the thought that there is a certain community of interest among owners of irrigated farms which should

not be disregarded when it is found necessary to undertake drainage operations.

A clear account of methods of draining which are applicable to such cases really involves a description of the surface and particularly the physical features of irrigated tracts in widely separated localities where special methods of draining have been employed, not omitting the difficulties which present themselves when such reclamation is attempted.

To those who are accustomed to draining lands in the humid sections the arid soils present some striking differences in structure and in the manner in which they become wet, as well as in the effect which continued saturation produces on vegetation. Arid soils are usually a mass somewhat uniform in character and without subsoil, as we understand the term in humid sections. With the exception of the adobe class they contain but little clay, but are made up of disintegrated rocks, or in some localities of volcanic ash, sometimes interspersed with gravel, which changes their density and physical condition. They are not laminated or stratified, as are those in the rainfall regions, so we often find them fairly uniform in structure and fertile to considerable depths. The presence of hardpan interspersed at irregular intervals in some localities breaks up this homogeneous character, and, where found, is an important modifying factor in both irrigating and draining. While these are the general characteristics which distinguish them from soils in the rainfall belt, there are any number of differences peculiar to arid soils which give nearly as great a variety of conditions as we find in the humid areas.

CAUSES WHICH PRODUCE SEEPAGE.

The cause of seeped or oversaturated land is the waste from irrigation and leakage from canals and laterals. The skillful irrigator may insist that if no more water is applied than is needed for growing and maturing the crops, and that if the canals are so constructed that no substantial amount of water escapes into the earth, no land will become too wet for farming purposes. It is true that in many instances irrigators have been unduly prodigal in the use of water, particularly when the land is first subdued and watered. The art of economical irrigation is usually learned only when scarcity of water compels its less lavish use. In any event, under methods that we may expect will prevail, some waste of water will occur under the best of management, making draining in many places essential to profitable farming. For these reasons an account of drainage conditions in different localities and the methods of treating them, together with the results which have followed various drainage operations, will be of interest to the holders of irrigated farm lands.

It should be observed as a general truth that water which produces permanent saturation rises from the bottom of the saturated portion toward the surface. Waste from irrigation first passes downward until a hard stratum of earth is reached. This may be only a few feet, in which case the additions which accrue from the irrigation of a few years will bring the permanent ground water level to within 2 or 3 feet of the surface, at which time injury to farm crops will ensue. The distance to a horizon of hard material may be much greater and the intervening ground may permit free percolation, in which case a much longer time will be required to fill the soil, because of the larger reservoir capacity and the relief afforded by underdrainage. It is not the downward movement of water alone which occasions boggy or wet areas, but the lateral movement of ground water down a slope until a flat tract or surface depression checks the flow and causes an accumulation of water, which is made known by its appearance, not, however, until the lower parts of the soil have been filled. Such depressions or level areas receive the accumulated waste water proceeding from adjoining lands, which occupy a higher level. It will be seen that the saturated condition of the land which shows injury is not due to the water which is applied directly to irrigate it, but to the surplus which percolates from the higher lands, sometimes through considerable distances, until it reaches the lower flat or depression.

Drainage has been carried on in the West to such an extent that certain methods are now practiced with reasonable assurance of success. Reference to some of these will indicate the variety of procedure which is now followed, as well as the constructive difficulties which attend this class of improvements. The development along this line which has taken place during the last five years is most encouraging to holders of seeped land.

METHODS OF DRAINING IN THE BEAR RIVER VALLEY, UTAH.

The Bear River Valley in Boxelder County, Utah, is well irrigated and fertile and is occupied by careful farmers who grow sugar beets for the large factory located at Garland, as well as grains and alfalfa, all of which are profitable crops. The soil is a dark loam with a subsoil containing more clay than is usually found in the arid sections. Since 1906 the rise of soil water in many of the fields has been preceded by the appearance of alkali on the surface, which has killed vegetation. So serious did this condition become that some farmers were considering the abandonment of their lands. The successful drainage of a 40-acre field under the direction of this department showed the practicability of preventing the extension of the evil and of restoring the lands to productivity by draining. The

stable condition of the soil, so strikingly and favorably different from the larger part of seeped irrigated soils, makes the process comparatively simple. It is, in fact, an ideal locality for using drain tile, because a firm bed upon which to place them can be secured, and the earth is sufficiently dense to prevent troublesome washing of the soil into the drains when the fields are irrigated.

It is found here as elsewhere that the location and the depth of drains are two essentials which must be observed in draining. As previously mentioned, alkali and seepage appear upon levels at the foot of slopes or where natural percolation is checked by a reef in the soil. A survey of the subsoil by means of borings is more essential as a preliminary to the construction of drains than is a surface survey. The ground water coming from the lower depths, and being under a pressure or head which tends to force it to the surface, similar to the conditions which produce artesian wells, presents a condition which requires the drains to be placed where the water enters the land, as nearly as possible, thus cutting off the source of the saturation. The ditches for that reason must be deep, 5 feet or more being found necessary for the most effective work. A few lines of tile drains, if properly located and constructed, will frequently effectually dry a large field, whereas, if improperly located and laid at a shallow depth, any number of lines will produce little benefit. Since the time when the practicability of draining the lands in this valley was shown, a drain-tile factory has been established about 5 miles from Tremonton, where a fairly good clay for this purpose is found. This factory is operated by the Acme Clay Co., which is made up of enterprising farmers, such a factory being found necessary because of the lack of drain tile within a convenient shipping distance. The factory (Pl. XXIII, fig. 2) consists of a steam tile mill, one kiln, and some drying sheds. Clay is taken direct from the bank in cars which are drawn up an incline to a dumping platform, where the clay is shoveled by hand labor into the mill which molds the tiles. The freshly molded tiles are dried in the sheds which adjoin the mill and are then placed in the kiln and burned. The ware which is produced is red in color and hard, the latter quality being essential to a permanent drain in alkaline water-logged soils.

Hand labor is being displaced by steam trenching machines (Pl. XXIV, fig. 1), which work admirably in those soils. They excavate the trench to the full depth required at one passage, delivering the earth on one side convenient for back filling. A grading device permits the operator to control the machine and make the bottom of the ditch conform to the grade which has been previously established by a survey, without which precaution the construction of drains should not be attempted. These lands are more easily drained than are those in many other localities, and, furthermore, the salts which



FIG. 1.—EFFECT OF SEEPAGE AND ALKALI UPON A BEARING ORCHARD IN THE YAKIMA VALLEY, WASH.



FIG. 2.—COUNTRY DRAIN-TILE FACTORY IN THE BEAR RIVER VALLEY, UTAH.



FIG. 1.—TRENCHING FOR TILE DRAINS BY STEAM POWER, BOX ELDER COUNTY, UTAH.



FIG. 2.—DIFFICULTIES OF CONSTRUCTING DRAINS BY HAND LABOR, MONTROSE, COLO.



destroy the crop as seepage appears are largely sodium chlorid, or common salt, and disappear quite quickly without special treatment after the fields have been drained. The successful introduction of drainage in Boxelder County has relieved the farmers of a menace which threatened the prosperity of the entire region. Since drain tile can be manufactured in the locality and trenching can be done by steam power, the serious obstacle which stood between the farmers and permanent prosperity has been removed.

PROGRESS AND DIFFICULTIES IN WESTERN COLORADO.

The difficulties to be met in draining lands in the Uncompahgre and Grand River Valleys in western Colorado are quite different and more serious. The land is of a shale formation, which when wet becomes exceedingly soft, sometimes to a depth of 10 or 15 feet. The cultivated areas are frequently bordered on one or more sides by lands in which the shale is partially disintegrated and which convey the water from the higher irrigated land, or possibly from irrigating ditches, into the "soil blanket," where it fills up the land so completely as to make a permanent bog. As a preliminary to draining such land soundings or borings are made to locate the position of the shale through which the water reaches the bog. Not infrequently it is entirely impracticable to place a drain through the wet part of the field because of its extremely soft and unstable condition. At least a part of the water must be intercepted and prevented from entering the field before complete drainage can be effected. This is accomplished by placing a drain on the edge of the wet tract in such a way as to penetrate the shale which delivers the water. When such a drain is constructed small streams of water which pour through the crevices of the shale, usually quite strongly impregnated with alkali, will be encountered. Where shale is found it furnishes a firm bed for the drain. Where, however, it is not found within the limits of the depth at which the drain is placed, it is frequently necessary to use a board or prepared frame in the bottom of the trench upon which to lay the pipes, and in addition to this to use gravel to prevent the wet material, which has almost the consistency of water, from entering and filling the drains. After the border drain has operated for a time, by diverting the water from the field, another drain may be laid through the lowest and wettest part of the field, the latter being usually necessary to take care of the surplus water, which is later applied in irrigating. In many instances the intercepting drain will effectually dry the land, but the lower soil having been completely filled with water by the process before described, some permanent drains must be provided to take the waste which will accrue from subsequent irrigation.

The difficulties of construction are often serious and perplexing (Pl. XXIV, fig. 2). The sides of the trench must often be sheathed closely to prevent the earth from caving and filling the trench before the tiles or wooden boxes, which are also used, can be placed in position.

COLLECTING PITS AND SAND TRAPS.

Sometimes it is not practicable to place the tile deep enough to collect the water which presses up from below, in which case pits are excavated 4 feet or more deep directly beneath the drain and are filled with gravel before the tiles are laid (fig. 6). These collect the water which rises and passes off through the drain and are found to be a valuable supplement to the ordinary tile or box drain.

Where a steam-trenching machine is used some device for sustaining the unstable earth until the tile can be laid must be employed (Pl. XXV, fig. 1). An outfit of broad-faced wheels, or in some cases a caterpillar type of truck, must be used to sustain the ma-

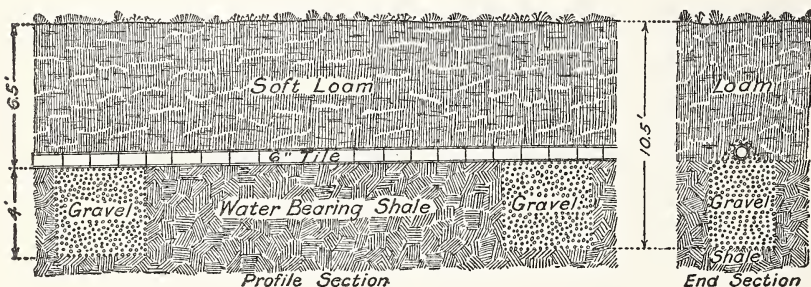


FIG. 6.—Collecting pits in connection with tile drains as used in Montrose County, Colo.

chine as it passes over the soft ground. It has also been found necessary in some localities to attach shields to the excavating wheel and a shield for the shoe to hold the trench open until the tile can be placed in position. This improvement is used at Montrose, Colo., and at Roswell, N. Mex. It is needless to say that draining under such difficulties is at best expensive, yet when we remember that one or two well-located and constructed drains will often dry an entire field of considerable size, the cost per acre is quite reasonable.

Sand traps or silt wells are a necessary adjunct to nearly all lines of tile drains, and should be placed at junctions with other lines and at convenient points along each drain. Their office is to cause the sand which is carried by the drain to deposit itself in the well, from which it can be removed when necessary. They are box wells, 3 by 3 feet in section, extending from a point 2 feet below the drains to the surface of the ground. The drains discharge into the well, dropping the sand which was held in suspension, the water passing out through the drain on the opposite side.

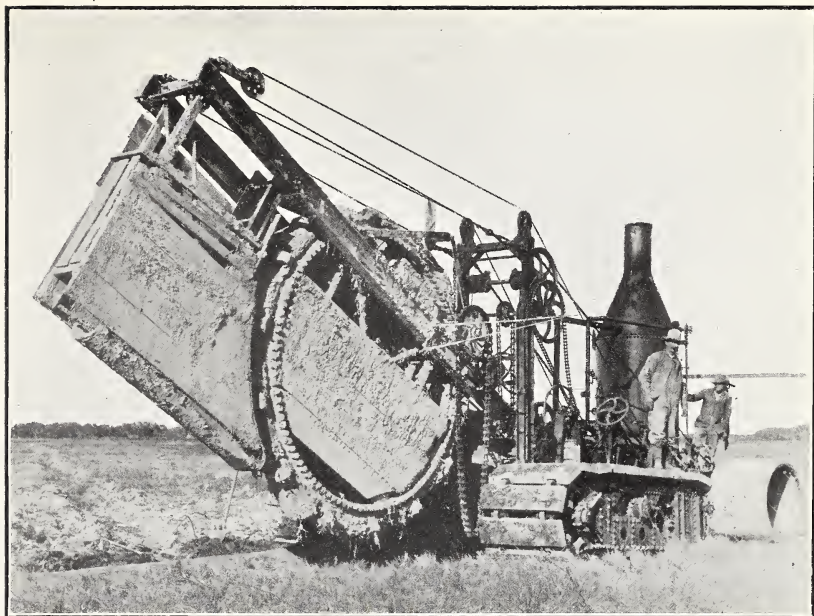


FIG. 1.—STEAM TRENCHING MACHINE EQUIPPED FOR SOFT LAND, ROSWELL, N. MEX.



FIG. 2.—DITCHING WITH A STEAM LAND DREDGE, MOXEE VALLEY, WASH.



SPECIAL RELIEF WELLS AND DISCHARGE DRAINS.

Reference has been made to the utility of "relief wells," as they are commonly called, for reaching and removing water which lies deeper than it is practicable to construct drains. This system is employed with most gratifying effectiveness where a gravelly soil disappears beneath a blanket of loam. The gravel permits a relatively free flow of waste water into the loam soil lying upon a lower level, where it remains to fill up the soil and produce a boggy condition. Relief-well drainage consists in sinking wells of greater or less diameter into the water-bearing gravel, which is found on the

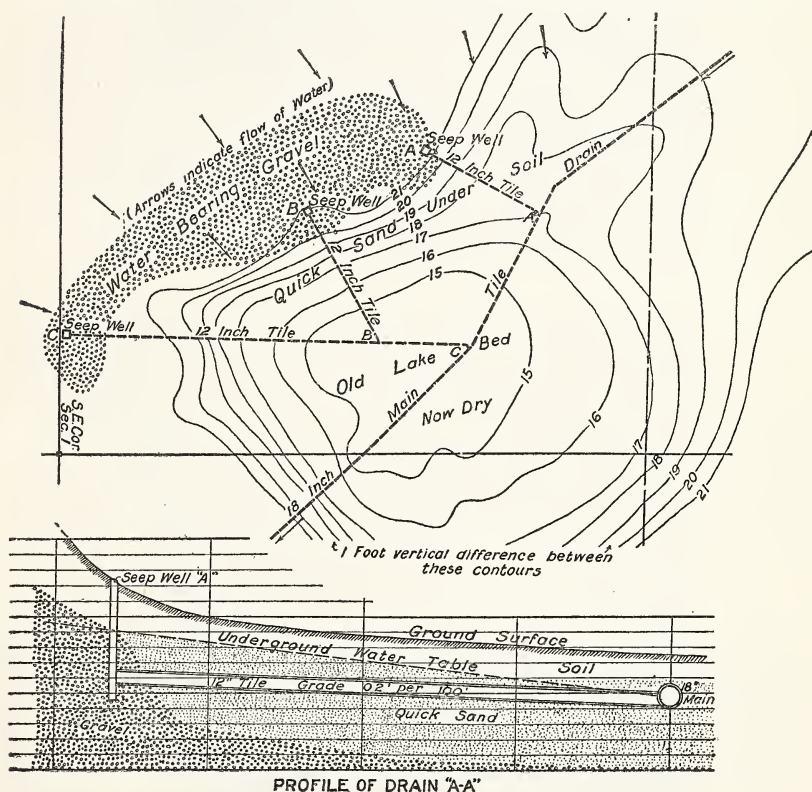


FIG. 7.—Plan and profile showing relief drainage wells as used in Otero County, Colo.

outer edge of the loam area at points where the gravel ceases or dips under the blanket of loam. Large tile drains are then laid at a convenient depth to connect the wells with a watercourse or large ditch. This plan of drainage has been used by Mr. Albert R. Beymer on the lands of the American Sugar Beet Co., in Otero County, Colo., with remarkable success wherever gravel can be located. The method was first recommended in 1902 by the writer, and has been found successful in other localities wherever the conditions are favorable. Figure 7 represents the conditions under which

the plan operates successfully. The wells are usually not less than 9 feet deep and 3 by 4 feet in section, commonly curbed by plank, and the outlet drains are laid about 4 feet deep, in the manner shown in the figure. Three or four wells with their respective outlets will sometimes drain 100 acres in localities where any number of tile drains laid through the wet land in the ordinary way would prove ineffective.

STEAM LAND DREDGES.

The methods so far described are those which pertain to drying the field. Covered drains are always preferable except where the volume of water becomes so great that they can not be used on account of the cost. Open ditches must then be constructed where outlets for large areas are required. The construction of such ditches through land which has become seeped and soft is often attended with considerable difficulty, as well as is their maintenance after construction. The steam land dredge is employed, as other means for excavating the ditches have been found impracticable where the ground has become saturated to a considerable depth. The difficulty of excavating such ditches emphasizes the wisdom of constructing the necessary drains as soon as the need of them appears. A drag-line bucket dredge which moves ahead of the excavated ditch is well adapted to the work. (Pl. XXV, fig. 2.) The platform upon which the machine is mounted is moved on rollers or on skids ahead of the ditch as it is excavated. Ditches about 8 feet deep, and located so that all drains within the area to be restored can be discharged into them, are a necessary part of the reclamation of any large area of seeped lands. (Pl. XXVI.)

MAINTENANCE.

Constant attention will be required to maintain open ditches in proper condition. They are subject to obstruction by the accumulation of Russian thistles and other weeds which the wind carries into them, and to filling by soil which is washed from the adjoining lands by waste water, when the fields are irrigated. Covered drains must also receive attention in soils which do not become compact and firm over the drain, for the reason that whenever the land is irrigated water will quickly find its way into the drain, carrying with it an amount of soil which will soon fill and obstruct it. This inconvenience and risk disappears as the earth with which the trench is filled becomes compacted, which condition is hastened if special care is taken in packing the earth at the time the trench is filled. Attention to the many details of construction and maintenance which can not be enumerated here are required in draining irrigated fields.



FIG. 1.—A DRAINAGE DITCH MADE WITH A STEAM DREDGE IN THE YAKIMA VALLEY, WASH.



FIG. 2.—HAND-EXCAVATED DRAINAGE DITCH CURBED TO PREVENT CAVING, SUNNYSIDE, WASH.



CEMENT DRAIN TILE.

No little discussion has arisen concerning the utility of cement tile for draining seeped lands, especially those which are strongly charged with alkali. The scarcity of well-burned clay tile, as well as of good clay for manufacturing them, in regions where they are most needed, makes it desirable to use cement if it is possible to do so. The experiments made in 1909 by R. A. Hart, drainage engineer of this office, published in the Transactions of the American Society of Engineers,¹ indicate that the presence of salts such as are found in soils hastens the setting of the cement and increases its tensile strength on a 30-day test. Exposure for 28 days in solutions of different kinds of alkali appears to point to the fact that the sulphates attack and destroy the solidity of the sample, while the chlorids and carbonates do not. The evidence furnished by tiles which have been in operation is conflicting, some having remained intact for 10 years and still manifest no sign of disintegration, while others apparently as well made have failed within a year. Those who have experience in the use of this material maintain that if tiles are molded from a mixture of one part good cement and three parts of the aggregate used in a wet state, they will resist injury by alkali. The varieties of alkaline salts which are found in seeped lands is so great, and their possible combinations are so numerous, that the use of cement tile for draining such lands is attended with considerable risk. Experience so far suggests that the pipes should be made dense and practically nonabsorptive if they are to be safely used in water which contains a considerable amount of alkaline salts from the soil. Even clay tiles which are soft or poorly burned should be discarded on the score of probable disintegration if they absorb water freely. What are known as "seconds" at sewer-pipe factories are excellent for draining and are quite commonly employed where tiles of large size are needed.

WOODEN BOX DRAINS.

The subject of material which is used for drains should not be passed without reference to wooden boxes, which, of necessity, are employed in many localities because more lasting material can not be obtained at a reasonable cost. They serve an excellent purpose while they last and have been exceedingly useful in experimental drainage where the doubtful results of the experiment did not seem to warrant the use of more expensive material. They are made in rectangular form, with or without bottoms, according to the ground in which they are to be used. If the bed upon which they are to be laid is hard clay or gravel, no bottoms are needed unless the fall of

¹Trans. Amer. Soc. Civ. Engin., vol. 67, p. 587.

the drains is considerable. Generally it is necessary to provide bottoms to prevent them from becoming choked with sand or mud. The boards forming the bottoms are separated from the sides by pieces of one-half inch lath, which makes an opening for the entrance of water on each side of the box. All other parts of the box are made tight. So soft is the ground in many cases that it becomes necessary to surround the box with gravel to prevent the entrance of mud through the openings in the boxes, small though they may be. The boxes are made in lengths convenient for use, and vary from 8 feet to 16 feet. Their use should not be discouraged except where the more lasting drain tiles can be obtained at reasonable cost. Lumber is not durable except where it is constantly saturated. This condition exists where some drains are used, but not in others, so that it is wise to secure hard-burned drain tile for this work wherever it is possible to do so. The larger sizes only are required in this kind of work, which fact adds largely to the cost of the drain if the tiles are shipped from a distance, and often induces the drainer to use pipes that are too small.

COOPERATIVE DRAINAGE.

The successful drainage of the field and ranch has developed the necessity of more extended work to secure outlets which are adequate to receive the water from the several farms. Irrigated land has few, if any, watercourses, so that drainage water must be delivered through artificial ditches, usually to the same stream from which the water was originally diverted. The construction of such outlet drains requires the cooperation of the owners of land which is to be benefited. This is secured under the provisions of the State drainage laws, which permit owners of land to form a corporate district and distribute the cost of the work among the several owners in proportion to the benefit each will receive. The assessments so apportioned are collected as taxes and the proceeds applied to pay for the cost of such work as has been agreed upon. Each landowner within the district then has a right to use the outlets and participate in all of the benefits which will accrue from the work.

It is quite often the case that little or no field drainage can be successfully done until outlets have been made. Districts of this character containing 10,000 acres or more have been inaugurated in the States of Washington, Utah, and Colorado, but none has as yet been completed. This feature of drainage, which has but recently been forced upon the people in certain sections, is new and brings up some troublesome questions concerning the location of such drains as will prove of common utility, and also concerning the equitable

assessment of their cost upon the several tracts of land for which they provide drainage.

There are at least 800,000 acres of irrigated land which now require draining in order to make them profitably productive, the larger part of which will require the construction of outlet drains in which more or less cooperation of property owners will be required. After the land which is drained has become fairly free from alkali, with which it is often highly charged, the water flowing from the main drains becomes highly valuable for irrigating. Such water then becomes an asset, since it may be used to irrigate lands occupying a lower level. These questions have not yet been adjusted satisfactorily in connection with drainage projects. In fact, they are only broached when the necessity for public drainage districts requires their consideration. It is quite certain that drainage districts must soon be as much a feature of irrigated farming as they now are of agriculture in the humid sections.

BENEFICIAL EFFECT OF DRAINING ON ALKALI LAND.

One of the effects of over saturation in many localities is the accumulation of harmful salts, commonly called alkali, in the soil. Their appearance, which is manifested by the failure of crops, is frequently the first intimation the farmer has that his land has become too wet. Effective drainage removes the cause of the accumulation, yet special treatment is frequently required to remove the excess of alkali sufficiently for growing crops. Copious irrigation, followed by thorough and deep cultivation and the growing of alkali-resistant crops for a season or two, quite commonly restores the land to its former productive condition. Some fields, however, are so fully charged with salts, due to seepage and to neglect in the use of preventive measures, that a longer treatment by various methods of flooding, in connection with the relief that is furnished by drainage, is required. Complete drainage, however, is the first essential in such reclamation, but should be followed by liberal irrigation until the alkali has been removed sufficiently to permit the soil to grow a crop, after which the quantity of water may be adjusted to the actual needs of the crops which are to be grown. No fact has been more thoroughly developed or forcibly emphasized by drainage experiments and ordinary field practice than the value of timely attention to this subject as a preventive of seeped and boggy fields.

PUMPING DRAINAGE WATER FROM SUMPS INTO IRRIGATION DITCHES.

This method of disposing of drainage water has been found practicable in the Fresno district of California. That great irrigated plain is not traversed by streams which can be conveniently utilized

as drainage outlets. The plan of discharging tile drains into sumps about 10 feet deep, located at a convenient supply lateral or canal, and establishing a small pumping plant at each to lift the water into irrigating canals was proposed by the writer in 1903, and is described in circulars Nos. 50 and 57, and further in Part IX of Bulletin 158 of this office. This method was put in operation experimentally in 1906 and 1907, under the supervision of irrigation investigations of this office, in which the owners of the land upon which the plants were located and the State of California cooperated. The results of this investigation and experiment are set forth in Office of Experiment Stations Bulletin 217. The plan, briefly stated, is to discharge the water from a system of tile drains into a sump or well 9 feet or more deep. A vertical centrifugal pump is placed at the bottom, the shaft extending to the surface, where it is operated by an electric motor connected to the pulley by a belt, a power line through that section making the use of electrical power possible and practicable. The water which is pumped is not sufficiently charged with alkali to unfit it for irrigation, especially when diluted with the water supply of the canal into which it is pumped. As a result of this investigation and trial of the plan originally proposed, which was successful, the method is now used on two fruit ranches where drainage systems and a pumping plant have been installed entirely at the owner's expense, and the land is being effectually reclaimed from the evils of both seepage and alkali. Since this land is 20 miles distant from a gravity outlet, the ability to accomplish drainage in this manner makes it possible for individuals to drain their lands without being dependent upon the organization of a large cooperative outlet scheme, which, however, ought to be worked out whenever it is possible to do so.

It may have occurred to the reader that there are some striking characteristics in the development of drainage methods for irrigated land when compared with ordinary practice in the humid sections. The ineffectiveness of drains which are laid 3 or 4 feet deep has been repeatedly demonstrated. The many failures in the West of methods which are commonly practiced and are successful in the East at one time gave abundant support to the belief often expressed by those who made the attempt that such land could not be drained. Costly experience has fairly well established the fact that 6 feet is about the minimum depth at which drains should be placed under the conditions which usually prevail in irrigated fields. Instances might be mentioned where a series of shallow drains which failed to accomplish the expected result have been replaced by drains 6 and 7 feet deep with satisfactory results. Two reasons for this increased depth may be given. First, if the drains are not deep they will not intercept the underflow, and therefore will have no effect in diminishing the vol-

ume of water which causes saturation; and, second, the capillarity of the soil is such that if the free water of the soil is not kept low, moisture containing alkali will be brought to the surface and the salt deposited when the moisture disappears as vapor. Again, the plan of using a few well-located and deep drains to intercept the underflow before it reaches the land which requires drainage is not commonly employed in regions of plenteous rainfall for the reason that in the latter case drainage consists in removing the surplus water which falls directly upon the field, while in the former it is the removal of the surplus underflow which percolates from an adjoining tract of land.

The method of draining by relief wells, which has been described quite fully and its value emphasized, is but the adaptation of what is known as the Elkington system to the drainage of irrigated lands. The method of tapping underground springs, which cause seeped and boggy lands, by means of wells, was originated by Joseph Elkington, of Warwickshire, England, in 1765, and was introduced in Sweden by George Stephens in 1806, with most excellent results. In 1795 Parliament voted Elkington £1,000 in appreciation of his services in discovering and developing a method of draining which had proven of great value to the Kingdom. In profiting by this discovery, which is so applicable to the betterment of our saturated irrigated lands, it is only fitting that we give Elkington due credit.

The developments of the last few years have forced upon our attention the necessity of draining and at the same time have increased our confidence in the practicability of reclaiming seeped lands and of restoring them to their former productiveness. It is quite clear to the careful observer that the application of the various methods which have been described will soon be extensively practiced in many sections of the irrigated West.



THE GUAM AGRICULTURAL EXPERIMENT STATION AND ITS WORK FOR THE FISCAL YEAR 1910.

By JOHN B. THOMPSON, *Special Agent in Charge.*

THE STATION.

The tract of land upon which the experiment station was established in the year 1909 has been purchased during the year just ended. The tract is located on the principal road of the island between Piti, the landing from the Harbor of Apra, and Agana, the capital and largest city. The selection is a desirable one, for a more public location could not have been obtained upon which to conduct work which must necessarily be largely of a demonstrational nature. The land is evenly divided into level-lying and hill land, giving scope for experimentation on soil types that represent a large portion of the soil of the island. A survey of the tract has just been completed which shows its area to be almost 32 acres. Its elevation ranges from 5 to 6 feet at the lowest to about 150 feet at the highest point. The soil has for the greater part a light surface layer deficient in organic matter and a heavy clay retentive subsoil. (Pl. XXVII.)

IMPROVEMENTS.

At the beginning of the year about 9 acres had been cleared of brush and plowed, while other land still remained in a wild state, the low-lying flat land being sodded to a number of native grasses, dotted here and there with clumps of guava (*Psidium guajava*) and other species, while the hill land was in most part covered with an impenetrable thicket of limoncito (*Triphasia trifoliata*) and other jungle brush. The work of clearing and plowing this land was a difficult task which occupied most of the time during the period of heavy rains when little could be done to advance other farm operations. About 15 acres, comprising most of the tillable land not previously cleared, was brought under the plow before the end of the wet season and seeding time arrived.

Traffic for four months of wet weather reduced the roads, which were earth trails, to an almost impassable condition; and in order to prevent the necessity of driving over plowed fields and growing crops the construction of better roads was deemed a necessity. Accordingly, during the dry season the construction of nearly 3,500 linear feet of

road from cascajo, a sort of limestone gravel and the common road material of the island, was completed. A cascajo hill on the station grounds has furnished an abundant supply of this material close at hand, facilitating the work greatly. The roads have been built only 10 feet wide, but are good, permanent, and adequate to the needs of the station.

Along the east line of the station grounds, stretching from the north line to the hill, a distance of about 900 feet, lies a strip of very low land, forming a basin in which water collects and is retained. This covers an area of about 2 acres in extent, all of which during periods of heavy rainfall has been entirely submerged for many weeks. During the year this swamp has been reclaimed by a system of drains. The ground is quite flat and receives the surface flow from an extensive watershed, so that even now during heavy rains it is under water; but as the rains subside this is carried away quickly through the drains, leaving crops which are now growing upon the land undamaged.

Lumber has been received from the United States for the erection of an office building which is now nearing completion. The building measures 20 feet in width and 40 feet in length, and has a veranda extending along the front and on both ends. It will have two office rooms, a library room, a room for laboratory and records, a dark room for photographic work, and a toilet. This much-needed improvement will insure greater protection to equipment, allow a more thorough system of records, and will render possible the enlargement of the library, which has not been feasible under the coconut roof of the old building rented as a temporary stopping place.

A bodega or storehouse is also planned which will have ample capacity for housing all the implements and farm tools. This building will be 18 feet wide and 45 feet long, and is to be constructed from native lumber. The logs have been purchased and are waiting at the naval station sawmill for sawing.

An irrigation and water-supply plant was secured from the United States. Water will be pumped from a well at the base of the hill into a reservoir constructed on the hill at an elevation of about 85 feet, from which it will be conducted to all parts of the land below through a system of 2-inch pipe. The reservoir, the excavation for which has been completed, will have a capacity of about 25,000 gallons. Water will be lifted to the reservoir by a centrifugal pump operated by a 12-horsepower kerosene engine. The engine will be placed in the implement building now under way, to furnish power for operating rice hullers, feed mills, or other machinery that may be found necessary in the future.

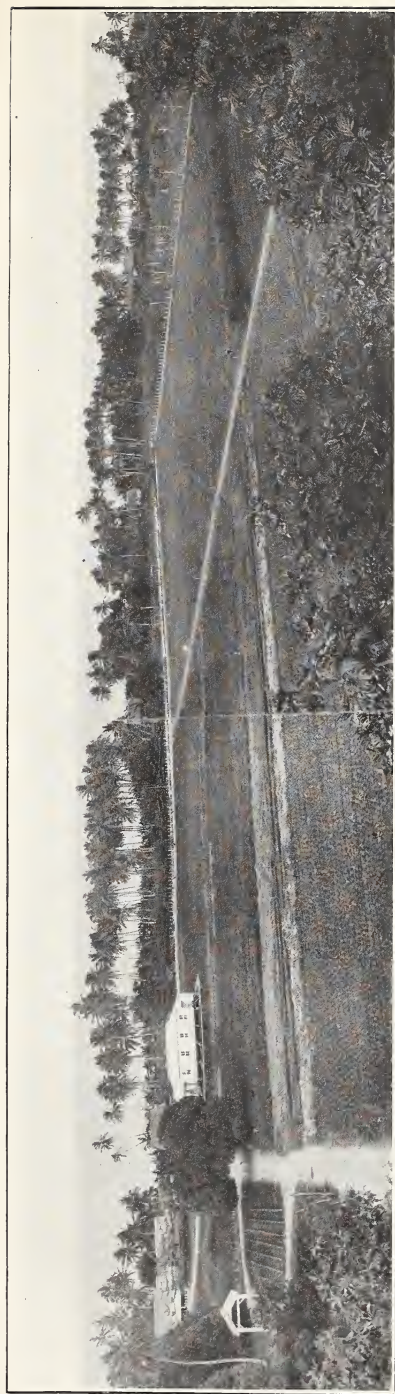


FIG. 1.—GENERAL VIEW.

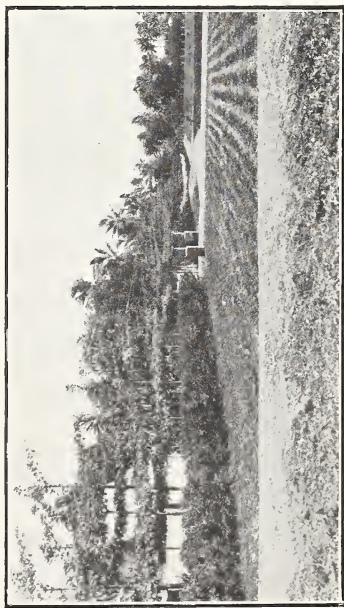


FIG. 2.—ENTRANCE TO EXPERIMENTAL GROUNDS.

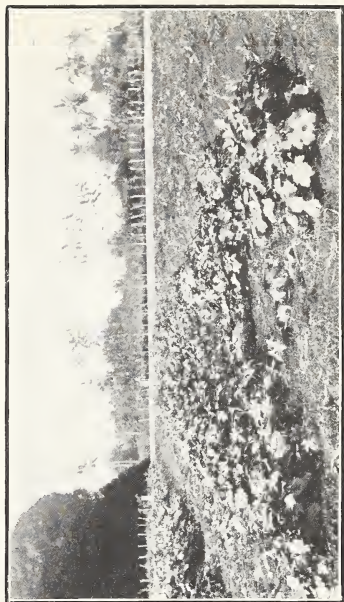


FIG. 3.—SQUASHES.

VIEWS OF THE GUAM EXPERIMENT STATION.

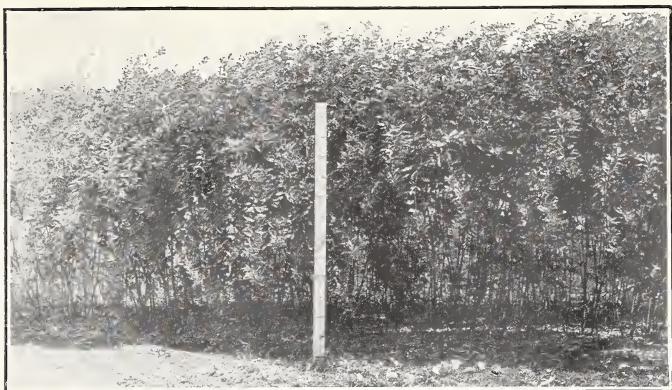


FIG. 1.—PIGEON PEA.



FIG. 2.—JERUSALEM CORN.

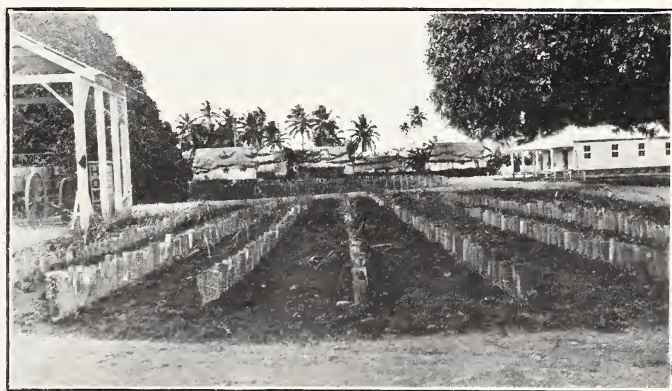


FIG. 3.—NURSERY, SHOWING PLANTS IN BAMBOO POTS.

CROPS GROWN AT THE GUAM EXPERIMENT STATION.

FORAGE CROPS.

Looking forward to the introduction of live stock from the United States, special prominence has been given to the work of testing the adaptability of crops used for stock feeding. (Pl. XXVIII.) Among those that have been successfully grown, the sorghums have proved specially valuable as soiling crops, and easily surpass all others that have been under observation for this purpose. Kafir corn has produced a crop amounting to $7\frac{1}{2}$ tons of green feed per acre on rather poor soil. The time required to produce the first crop was about three months when planted during the dry season, and two succeeding ratoon crops, which yielded about the same amount, were cut at intervals of about six weeks. Broom corn and sweet sorghum show about the same results in the production of green fodder. Both Kafir corn and Egyptian corn have yielded good crops of grain.

Guinea grass (*Panicum maximum*), secured from the Hawaii Agricultural Experiment Station at the close of the last year, was planted on poorly drained soil, and consequently made little headway during the wet season. Later all roots were taken up and subdivided in order to extend the area, and planted on soil which proved to be lacking in fertility. Just one good crop, yielding over 12 tons per acre, has been cut from this plat. Growth, however, on a small area indicates that on soils adapted to its growth, this grass will prove a valuable forage crop. When grown under favorable conditions it furnishes an abundance of succulent and nutritious feed which is relished by all classes of live stock.

Johnson grass (*Sorghum halepense*), also obtained during the previous fiscal year, has grown quite satisfactorily throughout the entire year. Roots for the initial planting were obtained from Mr. Joaquin Diaz, of Piti, who introduced it from the island of Saipan. The same tendency to retain occupation of the soil and to spread to other land that makes it a serious pest in the Southern States is observed in its behavior in Guam. It has been thought best to discourage the distribution of this otherwise valuable species on account of its dangerous habits, and requests made by planters for roots for planting have been refused.

Seeds of large water grass (*Paspalum dilatatum*) were obtained from the Office of Forage Crop Investigations, Bureau of Plant Industry, at the beginning of the year, and this grass has grown throughout both the wet and dry seasons with excellent results. Its adaptability to withstand extreme conditions of drought and rainfall adds much to its value as a pasture grass for Guam. It thrives well on poorly drained soil during long periods of heavy rainfall, where Guinea grass would be killed out or at least produce but little feed. It also does well without irrigation during the dry season when

pasturage from wild grasses is scarce. This grass is one of the most important developments of the forage investigations for the year, and when the time comes for the introduction of improved breeds of live stock an area devoted to it is planned to provide pasture.

Among other forage plants that have been under observation during the year, Para grass (*Panicum molle*) has been introduced quite recently, and its adaptability to conditions is not yet determined. Alfalfa has grown well during the dry season, but its success during the approaching long season of heavy rains is doubtful. Cowpeas and velvet beans have grown well.

The system of cattle management followed by the Chamorro farmer does not require the production of feed from cultivated crops. Wild grasses are depended upon, though during the dry season pasture becomes very poor. In the vicinity of towns, carabao and cattle are kept tethered to stake, and when pasture is scarce the fleshy stalk of the banana or the leaves of the breadfruit (*Artocarpus communis*) or other trees are cut and thrown to them. The adoption of the method of planting some of the forage plants that have proved successful and of easy cultivation would result in an improvement of the class of cattle; but it is difficult to impress on the people the necessity of doing work to supply feed for this class of stock. The horses are not as hardy as are the native cattle, and consequently they will not live with the same lack of care. There is a demand for a plant that will produce good fodder for these animals, and many requests for seed have been received at the station. There are a number of fields of Kafir corn being grown by the Chamorro farmers in the vicinity of the station. Most of this Kafir corn is thriving and the owners seem well satisfied with the results. It is believed that interest will continue to spread and in time the production of cultivated fodder crops will be a common practice among owners of live stock.

VEGETABLE EXPERIMENTS.

A large number of varieties of vegetable seeds have been received from the United States and tested out in our trial grounds during the past year. Though the average native of Guam is fond of garden products, he gives too little attention to the work of producing them. An ordinary garden consists of a few plants, including probably a few peppers, one or two tomato plants, a few eggplants, and a few plants of one of various species of pole beans. These are planted near the house upon unfenced ground, where they are ever in danger of being broken or trampled out by stock. The station is making an effort to obtain better varieties than are now grown to determine the best methods and time for planting under conditions in Guam and to encourage the people to plant more extensively and to adopt more careful and more thorough methods of cultivation.

Among those vegetables that have been grown successfully are beans, eggplants, radishes, okra, peppers, lettuce, cucumbers, muskmelons, and watermelons. Beets grew quickly and had attained a dimension of almost 2 inches in diameter when a lepidopterous larva appeared upon the leaves in such numbers as to completely riddle them before their presence was noted. It is evident, however, from the behavior of this small plat of beets that they can be successfully grown on the island. Cabbage failed to mature heads, but it is believed that upon more suitable soil and with modified methods of cultivation better success might be had. Improved varieties of the tomato have not been successful. The plant has usually grown vigorously, but fruit fails to set. The quality of the few fruits obtained was a great improvement over that of the very small seedy native variety, but the extreme light yield makes their production, based upon such returns, impracticable.

The work of introducing and testing the adaptability of new varieties will be continued, and whenever varieties are found to possess qualities making them specially valuable an effort will be made to introduce them into general cultivation. Already some interest has been shown in this work and many requests have been received for seed of varieties grown at the station. Requests have been specially numerous for seed of American varieties of eggplants and watermelons, most of which are decided improvements over the native varieties commonly cultivated on the island.

GRAIN-STORING EXPERIMENTS.

In Guam two conditions exist which prevent the storing of grains in quantity for any considerable length of time. One of these is the presence of the grain weevil, which attacks in large numbers and completely ruins certain grains in a few days' time; the other is the humid atmosphere, which keeps the grain damp and causes it to decay. Corn is usually kept in earthenware jars, called tinajas, which have a capacity of 5 or 6 gallons. During the wet season the corn is poured out of these about twice a week onto mats made from the leaves of the screw pine (*Pandanus tectorius*) and allowed to remain in the sun until the weevils are driven away by the heat and the grain has had a chance to dry. During a wet day there may be several showers interspersed with sunshine, and the necessity of carrying the corn to shelter and scattering it out again at every shower renders the process most laborious. To provide a method of storing grain permanently, and to eliminate all unnecessary handling, a closed tank made of galvanized sheet iron, which is hermetically sealed by the use of a heavy nonvolatile or slowly-volatile oil, has been devised. The arrangement is simple. The tank is built air

tight with the exception of a single opening at the top, into which grain may be poured or through which it may be removed. The station tanks (see fig. 8) have been constructed with the openings at the top quite circular and about 6 inches in diameter. Around the opening two concentric circular collars have been soldered to the top of the tank, the inner one (*D*) having a width of about $1\frac{3}{4}$ inches, and the outer (*E*) having a width of about $1\frac{1}{4}$ inches. The diameter of the inner collar is about 6 inches, while that of the outer one is

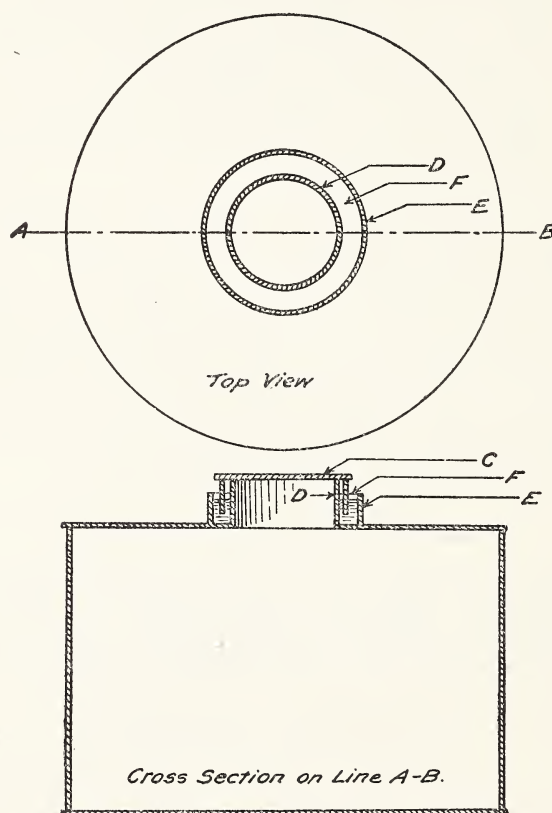


FIG. 8.—Grain-storage tank, Guam Experiment Station.

approximately 8 inches, thus forming a receptacle for holding the oil. When it is desired to close the tank, a cap (*C*), with the flange (*F*), made to fit closely over the inner collar is placed in position and the receptacle filled with coconut oil. The greater width of the inner collar prevents all possibility of oil entering the tank. All that is necessary in preparing corn for storing is to place it in the sun during a hot, dry day until a well-dried condition of the grain is secured, when it may be placed in the tank. Tanks thus sealed are proof

against the entrance of moisture-laden air and, if properly constructed, against weevils, which can not live in them. Corn placed in one of these tanks on December 16 was apparently in as good condition at the close of the fiscal year, after more than six months' storage, as it was when first stored.

HEDGE-PLANT STUDIES.

One of the most serious drawbacks to agriculture in Guam is the fact that cattle are allowed to run at large or are carelessly tied and commonly find their way into cultivated fields. The loss occasioned by the depredations of loose animals is a great discouragement to planters. Galvanized barbed wire is selling on the island at \$90 United States currency per ton, and under the climatic conditions of high atmospheric humidity, with the moisture of the air carrying a considerable amount of salt, the tendency is toward rapid deterioration of the wire. The high price and short life of wire practically prohibit the average farmer from using this style of fence. The cheapness and permanency of a good hedge fence should recommend it at least to all farmers who are tilling their own land. Hedge fences are sometimes grown by the native farmer of Guam, but these are usually of tangantangan (*Leucaena glauca*) or tubatuba (*Jatropha curcas*), both spineless, soft-wooded, brittle plants that are of little or no value for fencing. Several plants have been under observation at the station during the year, the most promising being the common camachile (*Pithecolobium dulce*), of which a fence over 700 feet in length has been started. This species is a hardy, deep-rooted, spine-bearing tree, which when cut back has a tendency to spread, and by proper pruning it is believed that it can be made both serviceable and ornamental.

PLANT INTRODUCTIONS.

Among the plants introduced during the year are the following: Five varieties of bananas, Maragogype hybrid and Amburayan coffees, sisal, Ceara rubber and cacao from Manila, five varieties of sweet potatoes, two of taro, roselle, papaya, and mammea apple from Hawaii, papaya from Java, sweet potato from China, and Eureka lemon, Mediterranean sweet orange, Triumph pomelo, and white Adriatic and California black figs from the United States. Besides a large number of shade trees and ornamental shrubs not mentioned above, a large quantity of camphor seed was obtained from Japan, but failed to grow.

IMPLEMENTS.

Eight five-tooth cultivators were brought in from the United States and sold to planters, and the fact that all these were sold within four days after their arrival indicates an interest in more modern methods of cultivating the soil. (Pl. XXIX.)

IMPORTS AND EXPORTS OF THE ISLAND OF GUAM.

The imports and exports for the fiscal year ended June 30, 1910, were as follows:

Imports and exports of the island of Guam, 1910.

IMPORTS.¹

Articles.	Quantity.	Value.
	<i>Kilograms.</i>	<i>Dollars.</i>
Ham and bacon:		
Japan.....	51	14.94
Hawaii.....	45	9.98
United States.....	52.6	13.70
Total.....	148.6	38.62
Lard: United States.....	155	42.75
Extract of meat: Philippines.....	15	1.10
Sausage: Philippines.....	245	130.40
Beef, mutton, and pork:		
United States.....	11,151	2,454.25
Saipan.....	577	132.66
Hawaii.....	144	22.80
Japan.....	2,073.3	506.87
Total.....	13,945.3	3,116.58
Milk:		
United States.....	1,009	227.54
Japan.....	640	197.87
Total.....	1,649	425.41
Butter and substitutes:		
Philippines.....	50	17.50
United States.....	42	50.90
Total.....	92	68.40
Cheese, all kinds:		
Japan.....	12	11.95
United States.....	78.7	39.68
Saipan.....	23	7.26
Total.....	113.7	58.89
Salmon, dried, and smoked:		
Japan.....	925	119.06
United States.....	1,762	224.60
Total.....	2,687	343.66
Salmon, salted:		
United States.....	20,936.5	2,540.92
Hawaii.....	8,730	487.93
Japan.....	2,127	178.70
Total.....	31,793.5	3,207.60
Fish, preserved:		
Saipan.....	124.6	13.23
United States.....	341.6	95.33
Philippines.....	30	20.86
Japan.....	7,377.7	2,033.96
Hawaii.....	12	5.20
Total.....	7,885.9	2,168.63
Vegetables, fresh: United States.....	102	4.80

¹ This list does not take into consideration the provisions received by the department of supplies and accounts of the naval station for Government use.

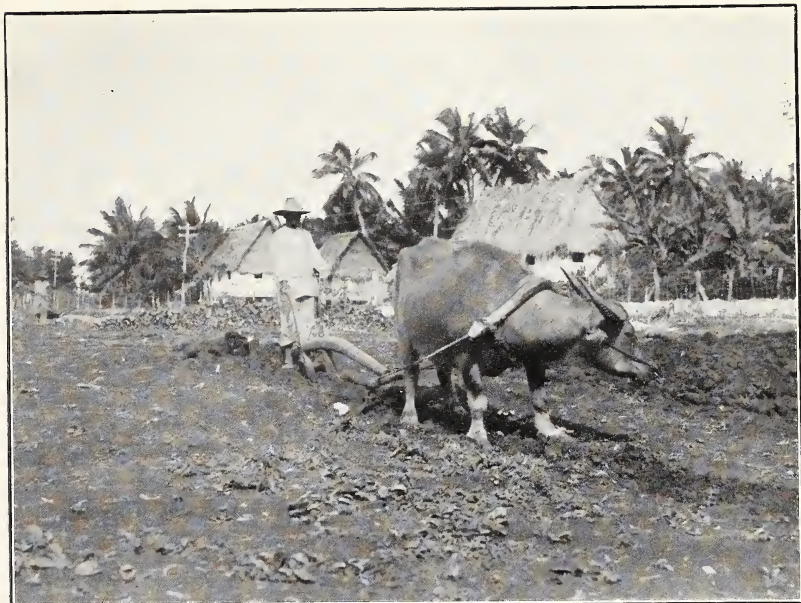


FIG. 1.—CARABAO AND NATIVE PLOW, GUAM STATION.

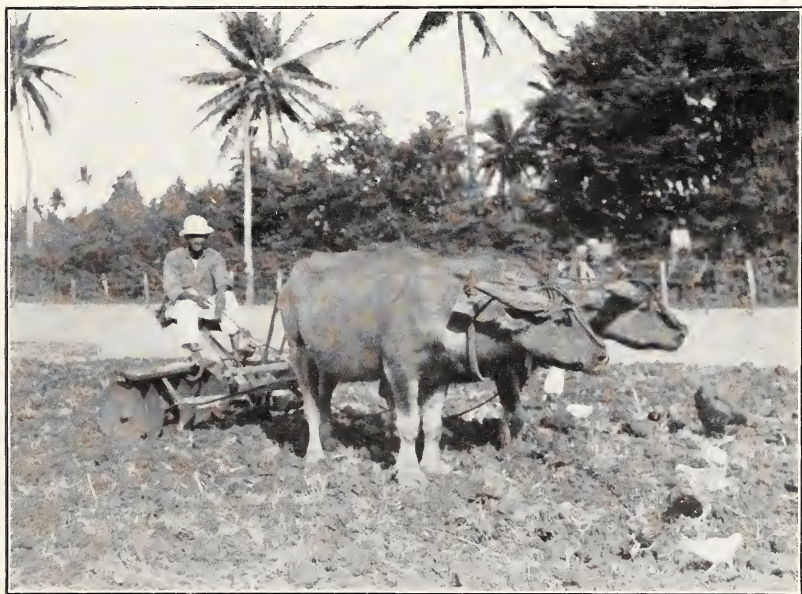


FIG. 2.—CARABAO AND DISK HARROW, GUAM STATION.

Imports and exports of the island of Guam, 1910—Continued.

IMPORTS—Continued.

Articles.	Quantity.	Value.
	<i>Kilograms.</i>	<i>Dollars.</i>
Vegetables, preserved:		
United States.....	4,462.7	614.54
Japan.....	3,999.5	335.67
Philippines.....	196	56.30
Hawaii.....	261	48.96
Saipan.....	339	36.61
Total.....	9,258.2	1,092.08
Onions:		
United States.....	1,141	52.99
Japan.....	1,410.5	86.57
Total.....	2,551.5	139.56
Potatoes:		
United States.....	963.8	44.15
Japan.....	1,398	38.89
Total.....	2,361.8	83.04
Fruit, preserved:		
United States.....	1,609.7	314.34
Hawaii.....	468	93.12
Japan.....	26	8.50
Total.....	2,193.7	415.96
Pickles:		
United States.....	436	109.65
Japan.....	92	13.20
Hawaii.....	30	10.50
Total.....	558	133.35
Olive oil:		
Philippines..... liters..	19	22.96
United States..... do.....	33.3	19.10
Total..... do.....	52.3	42.06
Flour, wheat:		
Japan.....	6,717.5	471.10
United States.....	34,087.5	2,261.38
Hawaii.....	234	25.60
Total.....	41,039	2,758.08
Wheat and grain, other than rice:		
United States.....	739.5	39.22
Saipan.....	283	7.00
Japan.....	250	8.30
Total.....	1,272.5	54.52
Rice:		
Hawaii.....	350	18.30
Saipan.....	6,000	232.60
United States.....	540	26.50
Philippines.....	22,727	1,456.25
Japan.....	315,540	12,064.75
Total.....	345,157	13,798.40
Chocolate:		
Japan.....	5	8.50
United States.....	718	193.71
Total.....	723	202.21
Coffee:		
United States.....	50.5	26.05
Hawaii.....	45	13.25
Total.....	95.5	39.30
Tea:		
Japan.....	138	65.26
United States.....	37	28.00
Hawaii.....	18	17.00
Total.....	193	110.26

Imports and exports of the island of Guam, 1910—Continued.

IMPORTS—Continued.

Articles.	Quantity.	Value.
Sugar, refined:	<i>Kilograms.</i>	<i>Dollars.</i>
Hawaii.....	2,377	227. 62
United States.....	10,856. 5	1,195. 25
Japan.....	2,263	456. 41
Total.....	15,496. 5	1,879. 28
Total imports of food products.....		30,354. 94
Miscellaneous imports other than foods.....		64,291. 33
Grand total of imports.....		94,646. 27

EXPORTS.

	Quantity.	Value.
	<i>Tons.</i>	<i>Dollars.</i>
Copra shipped to Japan.....	534½	33,610. 11





